MANAGEMENT, TECHNOLOGY, AND STRATEGY

FOR LARGE SYSTEMS

INPUT

About INPUT

INPUT provides planning information, analysis, and recommendations to managers and executives in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions. Continuing services are provided to users and vendors of computers, communications, and office products and services.

The company carries out continuous and in-depth research. Working closely with clients on important issues, INPUT's staff members analyze and interpret the research data, then develop recommendations and innovative id

needs. Clients receive reports, presentations, access to data on which analyses are based, and continuous consulting.

Many of INPUT's professional staff members have nearly 20 years' experience in their areas of specialization. Most have held senior management positions in operations, marketing, or planning. This expertise enables INPUT to supply practical solutions to complex business problems.

Formed in 1974, INPUT has become a leading international planning services firm. Clients include orld's largest and most techni- panies.

F-LS4 c.1
1983
AUTHOR
Management, Technology, and
TITLE
Strategy for Large Systems
F-LS4 c.1
1983

OFFICES

Headquarters
1943 Landings Drive
Mountain View, CA 94043
(415) 960-3990
Telex 171407

Detroit
220 E. Huron
Suite 209
Ann Arbor, MI 48104
(313) 971-0667

New York
Park 80 Plaza West-1
Saddle Brook, NJ 07662
(201) 368-9471
Telex 134630

United Kingdom
INPUT, Ltd.
Airwork House
35 Piccadilly
London, W1V 9PB
England
01-439-8985
Telex 23116

Data Service Company, Ltd.
uilding
Kita Aoyama
linato-ku
7

090
37

nsult
n & Co AB
4
Stockholm

20
41

any
ON GmbH
ethenbrunnen 1
D 6380 Bad Homburg
West Germany
Telex 418094

Italy
Milan 284-2850
Telex 310352

INPUT Planning Services for Management

000036

MANAGEMENT, TECHNOLOGY, AND STRATEGY FOR LARGE SYSTEMS

DECEMBER 1983


Digitized by the Internet Archive
in 2017 with funding from
Peter Cunningham

https://archive.org/details/12817FLS4__83MgtTechStrat

MANAGEMENT, TECHNOLOGY, AND STRATEGY FOR LARGE SYSTEMS

CONTENTS

		Page
I	INTRODUCTION	1
	A. Scope	2
	B. Methodology	2
II	EXECUTIVE SUMMARY	3
	A. Introduction	3
	B. Increased Competition for Large-Systems Service	4
	C. Pricing is Critical	6
	D. TPM No Longer an Option for Large-System Vendors	8
	E. Technology's Impact on Service	10
III	TECHNOLOGY AND PRODUCTS	13
	A. Introduction	13
	1. Trends in the Large Mainframe System Market	14
	2. Product Developments	19
	3. Plug-Compatible Mainframe (PCM) Developments	23
	4. Supercomputers	24
	5. Large Mainframe System Peripheral Devices Development	26
	a. Computer Memory Devices Developments	26
	b. Computer Terminal Developments	27
	6. CAD/CAM Systems Developments	29
	B. Large-System Internal Design Developments	31
	1. Improved Switching Speeds	31
	a. Distributed Array Processing	32
	b. Laser Technology	32
	2. Hardware Cost Reductions	32
	3. Main Memory Improvements	33
	4. Software Developments	34
	5. Improved Reliability Developments	35
	a. Redundancy and Fault Tolerance	35
	b. Failure Detection	38
	c. Remote Diagnostics Developments	38
	6. New Developments in Supercomputers	40
	C. User Attitudes Toward Large Mainframe System Suppliers	42
	1. Product Attitudes	42
	a. IBM	42
	b. Burroughs	42

©1983 by INPUT. Reproduction Prohibited.

		Page
	c. Honeywell	43
	d. NCR	43
	e. Sperry Univac	43
	f. IBM Plug-Compatible Systems Users	43
	2. User Attitudes Toward Large-System Vendor Service	44
D.	The Long-Term Future of Large Mainframe Systems	47
	1. Technological and Cost/Effectiveness Issues	48
	2. Market Segment Issues	50
E.	Changing Requirements for Service Management and Support of Large Systems	52
F.	Trends in Service Management Technology	54
	1. Service Call Handling and Dispatch	54
	2. Remote Diagnostics/Technical Assistance	54
	3. Order Processing/Inventory Control	54
	4. Return/Rehabilitation Control	55
	5. Data Management and Reporting	55
	6. Invoicing and Billing	55
	7. Other New Systems Developments	55
G.	Balancing Reliability, Responsiveness, and Productivity Tools	56
	1. Lack of Available Data on Equipment Failure Rates, Repair Times, Etc.	57
	2. Lack of Formal Reliability, Availability, and Serviceability (RAS) Design Considerations in Initial Product Development Cycle	57
IV	NEW DEVELOPMENTS IN SERVICE MANAGEMENT AND TECHNOLOGY	61
A.	Introduction	61
B.	Remote Diagnostics	61
	1. IBM Developments	62
	2. Hewlett-Packard Developments	62
	3. Amdahl	63
	4. Sperry Univac	63
	5. Honeywell	64
C.	User Self-Maintenance and Installation	64
	1. User Repair	65
	2. User Installation	66
	3. Board Swapping	66
	4. Depot Repair Centers	68
D.	Field and Depot Service Test Equipment	68
	1. On-Site Portable Automated Field Service Test Equipment	68
	2. Depot-Level Automated Test Equipment	69
E.	New Service Product Developments	69
	1. Time-of-Day and Day-of-Week Coverage	70
	2. Guaranteed Uptime	70
	3. Levels of Service Response	70

©1983 by INPUT. Reproduction Prohibited.

		Page
	4. Remote Diagnostic Service	71
	5. General Service-Level Agreement Specifications and Measurement	71
V	TACTICAL CONCLUSIONS AND RECOMMENDATIONS.....	75
	A. Introduction	75
	B. Major Tactical Problems	82
	C. Immediate Challenges for Service Management	83
	1. Increasing Use of and Interest in Third-Party Maintenance	84
	2. Trend Toward Fault-Tolerant and Remote Diagnostics Technology for Service Delivery	84
	3. Expansion of the Service Management Concept is Intended to Deliver Full Service to a Specific User	85
	4. Improvement of Product Management and Support	86
	D. Recommended Tactical Actions to Respond to Service Challenges	87
	1. Establish Formal Service Response and Repair Targets for Hardware and Software	88
	2. Implement a Fully Integrated Service Management Call-Handling Dispatch and Control System	88
	3. Introduction of Product Management Function	90
	4. Other Tactical/Strategic Initiatives	90
	a. Third-Party Maintenance	91
	b. Development of the Service Management Concept	91
	5. Recommendations	92
	a. Development of a Full-Service Portfolio	92
	b. Development of a Strategic Approach to Service Pricing for the Service Product Portfolio	92
	c. Development of a Service Management Concept of Service Operations	93
	d. Development of an Approach to Third-Party Maintenance	94
VI	STRATEGIC ISSUES IN FIELD SERVICE.....	95
	A. Introduction	95
	1. Scenario One: Emergence of Large- /Supercomputer-Based Systems	95
	2. Scenario Two: Introduction of Fault-Tolerant/ Remote-Diagnostics-Based Large Mainframes	96
	3. Scenario Three: Continuation of Current Dependency Upon Large Mainframes as Central Data Base Manager or Network Control System for Distributed Data Processing	96
	B. Strategic Organization and Operating Concepts	97
	1. Large Supercomputer Service Support Strategy	97
	2. Fault-Tolerant/Remote Diagnostic Large-Scale Systems Developments	100

©1983 by INPUT. Reproduction Prohibited.

Page

3. Large Mainframe Data Base and Communications Network-Oriented Systems Development 102
4. Summary 103
C. Recommendations for Long-Term Action 105

APPENDIX: QUESTIONNAIRE 111

©1983 by INPUT. Reproduction Prohibited.

000036

MANAGEMENT, TECHNOLOGY, AND STRATEGY FOR LARGE SYSTEMS

EXHIBITS

			Page
II	-1	Period of Increased Competition Looming in Large-System Customer Services	5
	-2	Pricing Will Become Even More Critical	7
	-3	TPM No Longer an Option for Non-IBM Large-System Vendors	9
	-4	Technology's Impact on Service	11
III	-1	Worldwide General-Purpose Computer Shipments and Installed Base - 1982	15
	-2	Estimated 1983 Market Share by Type of Equipment	18
	-3	Large-Systems Dissatisfaction with Key Services Offered by Vendor	45
	-4	Hardware and Software Response Time	46
V	-1	Overall Evaluation of Service Posture	76
	-2	Willingness to Pay Premiums for Extended Services	77
VI	-1	Alternative Service and Support Scenarios for Large Systems	98
	-2	Supercomputer Service Organization	99
	-3	Fault Tolerant/Remote-Diagnostics-Based Service Organization	101
	-4	Basic Field Service Organization	104
	-5	Strategic Issues and Conclusions	106

©1983 by INPUT. Reproduction Prohibited.

1 INTRODUCTION

I INTRODUCTION

- As a result of significant changes taking place with respect to the large-systems market, service management is faced with a number of challenges. These challenges stem from:

  - Increasing trends toward the large mainframes as part of an integrated distributed data processing systems network.

  - The development of very large, ultra-high-speed supercomputers employing artificial intelligence capabilities.

  - New developments in IBM plug-compatible systems.

  - The introduction of remote diagnostics technology as a general service delivery mechanism for large mainframes.

  - Increasing focus by the end user on service cost containment, responsiveness, and quality.

- In summary, service is becoming both more technologically intensive and more competitive. Thus, the service manager supporting large systems must become more innovative and more sophisticated in the ability to manage and control service, and to deliver cost-effective and responsive service by efficiently controlling all service resources (i.e., personnel, parts, and data), in response to changing customer needs and requirements.

©1983 by INPUT. Reproduction Prohibited.

- For the third-party maintenance organization, the large-scale systems market is a significant opportunity that is becoming more challenging as it becomes more technologically complex and competitive.

A. SCOPE

- This report concentrates on tactical and strategic conclusions and recommendations for large systems customer service organizations in regard to the technology trends, the service trends, and the challenges facing them.

- Where possible, references are made to market sizes, growth rates, and specific vendor products and service approaches. For the most part, however, the report focuses on the expected evolution of the large systems environment in the next five years, and how this evolution will affect the service organizations of participating vendors.

B. METHODOLOGY

- While interviews with users and vendors of large systems were the basis of the trends highlighted, much of the information presented is based on extensive secondary research of available public information, supplemented by INPUT's conclusions about the marketplace as a whole. The goal is to provoke vendors to rethink and evaluate their service approaches and their plans for the future.

- As always, comments and queries from clients are welcomed.

©1983 by INPUT. Reproduction Prohibited.

II EXECUTIVE SUMMARY

II EXECUTIVE SUMMARY

A. INTRODUCTION

- This Executive Summary is designed to help the busy reader quickly review the research findings of this report without having to read each section, while ensuring that the key points are not missed. Each main point is summarized as an exhibit, and an accompanying script is given on the facing page.

- The large-system marketplace has experienced a dropoff in its growth as the full impact of distributed data processing systems has begun to be felt. Its classical role of principal provider of processing and storage resources is being significantly affected by the proliferation of standalone minicomputers and microcomputers.

- However, every phase of decentralization is traditionally followed by a phase of "coordination" (another form of centralization), which places even greater demands on the processing and storage capabilities of the central system(s). It can be expected, therefore, that as the current expansion of minis and micros levels off (and the coordination phase, in the form of corporate networks and local-area networks, is implemented), large systems will enter a new growth era.

©1983 by INPUT. Reproduction Prohibited.

B. INCREASED COMPETITION FOR LARGE-SYSTEMS SERVICE

- Accompanying this (relative) slowing of growth in the large-systems market is the greater competition among vendors for the available business. This is generated by the natural play of market forces in the face of slackening demand, but also by IBM, which is turning the screws on its competitors, particularly the plug-compatible vendors, by announcing an almost continuous flow of new products or product enhancements, shortening the average product life cycle.

- Adding to the IBM pressure, U.S. large-system vendors should expect to witness over the next five years a determined thrust from the Japanese via large-systems products that leapfrog current price/performance levels. Companies such as NAS, already marketing Japanese products, will benefit from a sharply improved competitive edge.

- Responsiveness to customer service needs will, as never before, be a vital factor in retaining hard-won user bases. In addition, the profitability of customer service organizations will play a significant role in maintaining overall company profitability and continued viability. Success in this area is heavily dependent on a knowledge of the specific, unique needs of the vendor's customer base, and on a response that is appropriate with respect to service levels and contractual options.

- Integral to this response to the users' needs is the single-source maintenance contract, whereby the users' on-site equipment and software, whatever the source, is serviced by a single vendor contract. This is simultaneously a revenue opportunity, a strategic defensive move, and a response to customer needs (and therefore an enhancement of customer satisfaction). With the exception of IBM, it is increasingly necessary for large-system vendors to offer this option.

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT II-1

PERIOD OF INCREASED COMPETITION LOOMING IN LARGE-SYSTEM CUSTOMER SERVICES

- IBM Increasing Its Competitive Thrust
- Expect a Broad Attack from Japanese in '84-'89
- Responsiveness to Customer Needs Will Be All-Important
- Service Levels and Contractual Options to Customize Response
- Single-Source Management, TPM not an Option

PREPARE NOW

©1983 by INPUT. Reproduction Prohibited.

C. PRICING IS CRITICAL

- A fundamental element in the competitive profile of services offered is the positioning of those services in the price spectrum. In the past this has been a relative factor in large systems because of the lack of direct comparability in services offered. More recently, increased attention has been given to pricing by all system vendors and a new dimension is about to be added to this picture.

- For some time INPUT has monitored service prices and noted a steady decrease in contractual service costs at each level of the market. This was particularly evident in the large-systems area after the introduction of the IBM 4300 series, where service costs were set 70% below the service costs of the replaced 370 models. INPUT believes this trend is about to become more viable, driven by IBM and possibly the Japanese market entry.

- If straight one-on-one pricing is followed, some significant losses are likely for many vendors (who in the main generate nothing like the service margins that IBM does). Therefore it is important to focus on value-in-use pricing, where the emphasis is on the composition of the service package released by the vendor and on its overall cost, rather than on element-by-element pricing.

- To be able to implement this kind of pricing strategy requires a strong market segmentation of the user base, along the lines of demarcation of their service needs (again emphasizing the need for a precise knowledge of the users' needs). Each vendor's customer base has in common with every other the fact that it is not a single homogeneous mass of users with like needs. Complementing this approach will be the need to fine-tune cost-of-ownership benchmarking of service needs to obviate the need for one-on-one competitive evaluations and to emphasize overall service cost differences.

©1983 by INPUT. Reproduction Prohibited.

PRICING WILL BECOME EVEN MORE CRITICAL

- Downturn Expected in Industry-Accepted Levels of Pricing for a Given Service
- IBM Will Drive the Market Down, Possibly Assisted by the Japanese
- Value-in-Use Pricing Will Predominate
- Strong Market Segmentation Needed
- Cost-of-Ownership Competitive Evaluations Will Be Finely Tuned

©1983 by INPUT. Reproduction Prohibited.

D. TPM NO LONGER AN OPTION FOR LARGE-SYSTEM VENDORS

- In this new, highly competitive service environment it will be important for each vendor to:
  - Respond to the need for single-source maintenance.
  - Defend the installed base from predatory service offerings.
  - Be aggressive in obtaining extra service revenue.
- This essentially suggests that, in the complex, multivendor, large-system environment commonly found in the U.S. today, it is no longer possible for large-system vendors to consider third-party maintenance (TPM) as an option.
- Unlike any other computer-related market known to INPUT, this is a market that IBM is unlikely to enter, since IBM will view this as helping the competitor. This market should be taken advantage of as quickly as possible.
- INPUT's research suggests that users are very receptive to the single-source maintenance approach (which can take the form of service management contracts if TPM is not offered). This need can be simplified down to servicing the core system (i.e., those elements of the total system without which the user cannot function). This allows low-density products to be eliminated from the list of products for which TPM must be offered.
- It is important to realize that service market expansion is possible even in a slowing market, if the necessary competitive thrust can be mounted. Each vendor should therefore review the service products offered and compare them to the competition's in order to highlight strengths and weaknesses.

©1983 by INPUT. Reproduction Prohibited.

TPM NO LONGER AN OPTION FOR NON-IBM LARGE-SYSTEM VENDORS

- Multiple-Vendor Large Systems Are Now the Rule
- Only Computer-Related Market where IBM Is Not Found
- Users Very Receptive to Service Management Contracts
- Core Systems Service
- Own-Site Protection
- Competitive Thrust for Market Expansion

©1983 by INPUT. Reproduction Prohibited.

E. TECHNOLOGY'S IMPACT ON SERVICE

- Permeating the entire structure of the large-system service market are the developments in new technologies, and their impact on service. Many examples are provided in the body of this INPUT report, but briefly summarized they include:

  - The steady increase in product reliability that has been implemented by all major vendors (quality has become the watchword of American industry, not only in computers).

  - The increasing trend toward embedded diagnostics, particularly those that can be remotely accessed.

  - The growing modularity of large systems (and the increased integration of function in each module).

  - Overall fault tolerance improvements made and better accuracy of the in-built diagnostics.

- The counterpart of this improvement in hardware reliability, however, has been increased user awareness of the reliability of the vendor's software. INPUT's 1983 surveys showed a high degree of dissatisfaction with vendor software maintenance. It is necessary for vendors to begin improving the quality and fault tolerance of software systems so that they reach the same level as already provided in hardware systems.

- Despite the regular increases in price/performance ratios already achieved in large systems, the end is not in sight. Contrary to popular belief, which states that the curve of price/performance should soon flatten out, INPUT believes that order-of-magnitude improvements are in the wings and will continue the established trend. This once again underlines the need for innovative service methods that will match hardware performance improvements with steadily more responsive service.

©1983 by INPUT. Reproduction Prohibited.

TECHNOLOGY'S IMPACT ON SERVICE

- New Technologies Impact Service Through:
  - Increased Reliability
  - Embedded Remote Diagnostics
  - Increased Modularity
  - Fault Tolerance
  - Improved Accuracy for In-Built Diagnostics
- Hardware Reliability Improvements Highlight Need for Improvements in Software Reliability
- Major Increases in Large Systems Price/ Performance Will Continue to Occur

©1983 by INPUT. Reproduction Prohibited.

III TECHNOLOGY AND PRODUCTS

III TECHNOLOGY AND PRODUCTS

A. INTRODUCTION

- Significant developments are taking place with respect to the products and technology associated with large computer systems, including the development of both very high speed integrated circuitry using 256K chip structures and integrated computer/communications networking capabilities for high-speed transfer between distributed processing terminals and personal computer units.

- These new developments have a significant impact on the technology and approach to servicing and support of large systems equipment in the field.

- The primary technological developments in large-scale mainframe systems include:

  - Very large scale integrated circuitry.

  - Integrated network communications.

  - Very high speed memory.

  - Distributive processing.

  - Supercomputers and artificial intelligence.

©1983 by INPUT. Reproduction Prohibited.

- In addition to the impact on product design, new technological developments have been made that significantly improve the ability to service and support large mainframe systems in the field. These include:

  - The introduction of embedded remote diagnostic capabilities as part of the system mainframe.

  - Increasing modularization of individual functions down to the board level in order to use a "pull and replace" maintenance philosophy.

  - Fault-tolerant and ultra-reliable circuits and modules.

- In summary, for large mainframe systems, it is becoming increasingly easy to diagnose and evaluate problems via remote diagnostics capabilities over telecommunications lines, and to fix and repair equipment on a "pull and replace" philosophy rather than fixing on-site at the circuit and module level.

I. TRENDS IN THE LARGE MAINFRAME SYSTEM MARKET

- The large mainframe system market, which accounted for about 60% of the total value of all computer shipments in 1982, will experience the smallest rate of growth of all types of computer and office automation equipment markets.

- Shipments of general-purpose mainframe computers, which grew at an annual rate of some 17% during the late 1970s, have lost their rapid growth over the last few years. In 1982 the value of general-purpose computer shipments by U.S.-based manufacturers to the worldwide market was approximately $17.8 billion, as shown in Exhibit III-1. About 56% of this total was for domestic use.

- Shipments are now projected to grow just 7% annually to $24.7 billion by 1986. Currently, the mainframe market accounts for some 60% of the value

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT III-1

WORLDWIDE GENERAL-PURPOSE COMPUTER SHIPMENTS
AND INSTALLED BASE - 1982
(U.S.-Based Manufacturers)

COMPANY	ESTIMATED 1982 SHIPMENTS ($ Millions)	INSTALLED BASE		1982 SHIPMENTS AS PERCENT OF INSTALLED BASE
		UNITS	VALUE ($ Millions	
IBM	$12,300	70,000	$ 89,400	13.8%
Honeywell	1,470	16,800	11,510	12.8
Sperry Univac	1,350	8,000	9,200	14.7
Burroughs	990	9,650	6,900	14.4
NCR	480	7,850	2,540	18.9
Control Data	450	1,470	4,200	10.7
Digital Equipment	250	1,610	1,450	17.2
IBM-Compatibles (Amdahl, NAS, Etc.)	525	1,730	3,200	16.4
Total	$17,815	117,110	$128,400	13.9%

©1983 by INPUT. Reproduction Prohibited.

of all computer shipments, but this share is expected to decline to 40% by 1986, as the slower growth continues.

- Part of the slowdown in the mainframe market can be explained by the poor economic conditions in the U.S. and Western Europe during 1980-1982. Adverse business conditions have affected mainframe customers' capital equipment spending, high interest rates make financing more difficult, and many customers have delayed upgrades and new purchases of computers.

- Computer manufacturers generally sell a large portion of their equipment overseas, and in the last year or so, they have also had to contend with an unusually strong dollar, which penalized foreign computer sales by U.S. manufacturers. But this is not the main reason for slowed shipments.

- Competition from super minicomputers (made by Digital Equipment Corporation, Data General, Perkin Elmer, Prime Computer, and others) has increased. As their price/performance ratio has improved, superminis are eating into the low end of the mainframe market. There has also been a trend toward decreasing the amount of "bundled" software (i.e., software included in the price of the system), so hardware systems revenue has fallen as the software component has been removed. It is notable that software shipments to large system installations are rising rapidly.

- Despite this slowing hardware growth, the market is not about to fade away. Large customers' ever-increasing demand for the processing power that a large mainframe can provide will remain. Mainframe computer manufacturers have a very large installed base that provides a continual market for new products when customers want to upgrade their equipment. There is loyalty on the part of these mainframe customers, since a change to a vendor with noncompatible hardware and software would be enormously costly in file and program conversions.

©1983 by INPUT. Reproduction Prohibited.

- Large-system manufacturers have been trying to satisfy customer needs by improved pricing and performance of new products. Since IBM is the dominant force in the general-purpose large mainframe systems market, any new IBM pricing or product announcements are eagerly awaited by both customers and competitors.

- In 1983 IBM announced the 3084, a new top-of-the-line mainframe; a four-processor system with performance rated at 26 MIPS (millions of instructions per second), roughly twice as powerful as its previous top-of-the-line 3081K, which had been introduced only a year earlier.

- The 3084 is available only as an upgrade to the 3081K; the price of the system is the sum of the price for the 3081K and that for the 3081G (a replacement for the 3081D, with slightly greater performance at the same price). Over the past year IBM also added four computers to the mid-range 4300 line and three 3083 models that fall in between the 4300 and the 3081 series.

- While IBM essentially controls the mainframe systems market, it is less dominant in other markets, as shown in Exhibit III-2. However, IBM is a significant force in all of the data processing markets, whereas all other competitors are positioned in fewer segments.

- The IBM installed base of large mainframes has changed significantly. At the beginning of the 1980s, 90% of all IBM installed mainframes were 360s or 370s, with approximately 16,000 units installed. By the end of 1983 it is forecast that approximately 26,000 large IBM systems will be installed, with the greatest percentage (68%) being 4300s. The 360/370s will amount to less than 15% of the installed base.

- The large mainframe can be predicted to be used increasingly as:

  - The central manager of data bases and the central batch processing host supporting numerous small distributed mini, micro, and personal computers.

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT III-2

ESTIMATED 1983 MARKET SHARE BY TYPE OF EQUIPMENT

COMPETITORS	TYPE OF EQUIPMENT			
	Mainframes	Minicomputers	Business Microcomputers	Word Processors
IBM	74%	20%	28%	25%
Burroughs	7	6	–	–
NCR	5	3	–	–
Sperry Univac	4	2	–	–
Control Data	4	1	–	–
DEC	–	19	7	6
Hewlett-Packard	–	11	9	5
Honeywell	3	3	–	1
Wang	–	5	–	23
Texas Instruments	–	3	2	–
Prime	–	3	–	–
Tandem	–	3	–	–
Apple	–	–	18	–
Tandy	–	–	17	–
Commodore	–	–	10	6
Others	3	21	9	34
Total	100%	100%	100%	100%

©1983 by INPUT. Reproduction Prohibited.

- The central communications and data flow system, acting as the coordinator of a totally integrated network, providing both batch and on-line processing support via terminals, workstations, or PCs acting as terminals.

- Several major users are moving toward centralized control of network integration using the large mainframe. In addition, a number of other organizations are committed to centralized control of (at least) the system data bases. In essence, the ability to optimize communications and data between distributed processors and/or local terminals and microprocessors will, to some extent, dictate the future role of large mainframe systems.

2. PRODUCT DEVELOPMENTS

- Despite efforts to isolate computer applications and run them on minis and micros, the need to share information resources has increased the demand for integrated large mainframe systems capacity. Large application programs, distributed data processing, and office automation, all requiring central coordination and control, have driven mainframe design toward exceptionally large memory and multiple high-speed input/output channels.

- Major applications, such as on-line transaction processing and computer-aided design (CAD), have tended to remain on a large mainframe but have expanded to many terminals. An alternative route has been toward a dedicated stand-alone system. Large systems have become faster and more efficient, not only in response time as terminals are added, but also in accommodating users whose skill levels now range from those of clerk to computer expert.

- It is clear from the new product introductions that large mainframe system manufacturers are increasing their system throughput, both by decreasing machine cycle times and by incorporating increased parallelism at several levels.

©1983 by INPUT. Reproduction Prohibited.

- This trend toward parallelism is taking several forms: fully symmetric structures composed of two or more identical processors sharing functions and workload equally; software asymmetrical structures, in which identical processors are used to execute specialized tasks; and fully asymmetric systems in which specialized hardware, like array processors, provides the parallelism.

- The throughput of array processors appearing in the past year compares favorably with that of some supercomputers. Recent product announcements include:

  - IBM announced its largest processor, the 3084. This four-processor configuration is based on two Model 3081, Group K, dyadic processors that can be partitioned to operate as two independent systems.

    . In the multiprocessor mode, the 3084 has a main memory of 64 megabytes. The four closely coupled processors each have 64 kilobytes of cache buffer storage. The system has 48 I/O channels, and it is estimated to perform 27 million instructions per second.

    . Thus the newest IBM mainframe system continues to exploit the company's investment in TTL arrays of 700 gates per chip and the 1-ns switching speed of the 3081.

  - Burroughs Corporation broadened its family by adding the B-5920, a new entry-level computer for customers to grow within its medium- to large-scale series. It is intended for standalone use or as a remote unit in a distributed data processing network.

  - Control Data Corporation brought out the Cyber Series 800 large-scale computer family with five models, each compatible with computers in the previous Cyber 170, Series 700 family.

©1983 by INPUT. Reproduction Prohibited.

. The newer models, with memory of 60-bit words ranging from 262 to 2,097 kilobytes, are eight times larger than the maximum in the Series 700. Cycle times range from 400 to 75 nanoseconds. Prices start at $370,000 for the compact, air-cooled 825 and go to over $3 million for the 875. A greatly enhanced network operating system supports Series 800 computers in standalone configurations, multicomputer arrays, or as part of data processing networks.

. Somewhat hidden in the new Cyber series announcement was the quiet recognition of the growing number of microcomputer families in the marketplace. A remote micro facility was offered, allowing linkage of microcomputers from Apple Computer and Control Data's own CD 110 to the large Cyber 170 systems.

- Digital Equipment Corporation announced a dual, asymmetric multiprocessor version of its VAX 11/780. In the new systems, designated VAX 11/782, two processors communicate through a shared memory, with one handling highly interactive tasks and I/O while the other concentrates on computation. This kind of system is aimed at CAD applications, where users often require highly interactive data entry combined with computation programs for design or simulation. DEC also brought out a triple symmetric DEC 10 system, based on three KL10 processors sharing an interleaved memory. The new system can support up to 250 users.

- Cray Research announced a new dual-processor vector machine, the Cray X-MP. Two Cray 1 instruction-compatible processors are used, and their cycle time has been shrunk from 12.5 to 9.5 ns. The new computer executes up to 400 million floating point operations per second.

©1983 by INPUT. Reproduction Prohibited.

. An optional 256-megabyte MOS memory improves the I/O bandwidth, permitting transfers of up to 1,250 megabytes per second.

. To alleviate a bottleneck in long-vector operations, the Cray X-MP has four memory ports, compared with the Cray 1's single port. The first X-MP has been ordered by Digital Productions, a Hollywood film animator, which plans to use it for very high-resolution computer graphics for movies.

- National Advanced Systems announced its AS/1100 for interactive office automation. The entry put National Advanced Systems squarely into the fast-growing distributed data processing market.

- Fujitsu Ltd. of Japan announced two fast scientific processors, the Facom VP-100 and VP-200. The larger, faster VP-200 executes up to 500 million floating point operations per second and can have up to 256 megabytes of primary memory in 64-kilobyte static MOS RAMs with a 55-ns access.

• A major trend in large mainframe systems is to provide fully integrated network-based linkages to microprocessors and personal computers. Now under development are several software/hardware systems that enable a user at a micro or PC to take data stored in a mainframe, download into the micro, and use the data in a local application.

- For example, the 24 school districts in San Mateo County (CA) have developed a package called Xpress, a network communications system that interfaces DEC mainframes with micros/PCs from Apple, Radio Shack, and others.

- A number of vendors, hardware and software alike, have announced communications links for micros and mainframes, some merely facili-

©1983 by INPUT. Reproduction Prohibited.

tating the downloading of files and others making it possible for a user to selectively retrieve data elements. Among those is release 2 of MBA, an integrated software package from Context Management Systems in Torrance (CA). The MBA is currently available for the IBM PC and the HP series 200, model 16 personal computer. Using this software a user could retrieve data from any large mainframe and use it in, for example, a financial modeling program.

- IBM announced a personal computer compatible with the 370 and its popular 3278 terminal. The combination is expected to be quite popular at large companies with existing IBM 3270 networks.

3. PLUG-COMPATIBLE MAINFRAME (PCM) DEVELOPMENTS

- Plug-compatible equipment competes primarily with IBM, rather than the other major mainframe manufacturers, for approximately a 9% share of the general-purpose mainframe systems market. PCMs include computers and peripherals that operate as part of an otherwise-IBM system and can run on software written for IBM machines. The PCMs compete with IBM on a price/performance basis (as measured by millions of instructions per second). PCMs are vulnerable to IBM's moves and must be quick to anticipate or react to such changes.

- The PCM business has grown rapidly over the past several years despite relatively little penetration of IBM's customer base. PCMs try to capitalize on stretched delivery times of certain IBM products by filling the gap. They also try to attract new customers with price/performance advantages over IBM products. Amdahl and National Advanced Systems (a subsidiary of National Semiconductor) compete in the high end of the PCM market and hold some 90% of the PCM computer market.

- National Advanced Systems offers a much broader range of plug-compatible equipment than Amdahl, which makes large-scale computers only. National

©1983 by INPUT. Reproduction Prohibited.

manufactures medium-scale computers, while large-scale computers and peripheral equipment are made by Hitachi. National's top of the line is the AS/9080 with performance rated at 20.5 MIPS (million instructions per second). At the lower end of the market, IPL Systems, Cambex Corporation, and Formation, Inc., compete with IBM's 4300 series of computers. IBM's aggressive pricing policies have made this a very difficult market to penetrate.

- Competing in the PCM market is not expected to become easier, for the future holds continued changes in IBM's hardware, software, and microcoding, along with pricing pressures, and increased competition from potentially significant new entrants. Trilogy, which was formed by Gene Amdahl, the founder of Amdahl, plans to have large PCM computers available in late 1984.

4. SUPERCOMPUTERS

- Supercomputers, which are large-scale computers with speed and capacity far in excess of that available with the large general-purpose mainframe systems, are used primarily by governments and scientific institutes for weather forecasting, energy development, nuclear research, and other specialized purposes. The market potential is expanding with the rapid worldwide growth in computing needs and the increasing sophistication and complexity of problems being solved by computers. Newer fields using supercomputers include petroleum research, fluid dynamics, aerodynamic engineering, and structural analysis.

- The only significant U.S. suppliers of supercomputers are Cray Research and Control Data Corporation. The supercomputer market, which was about $250 million in 1982, is projected to grow 20% to 30% annually over the next few years as the need for this specialized type of number-crunching ability expands. Cray (founded by Seymour Cray, a former designer at Control Data) is involved in only one line of business: supercomputers.

©1983 by INPUT. Reproduction Prohibited.

- Cray dominates this market with approximately 20 installations. This is quite an achievement, since the prospectus for Cray's initial public offering noted that the entire worldwide market for computers of the type it was planning to build might be limited to 50 machines. These numbers do not sound very big, but each Cray computer costs the buyer between $4 million and $11 million. Since Cray ships relatively few machines, its sales and earnings can fluctuate widely from quarter to quarter depending on the sales/lease mix and the date of installation of the machine.

- Cray announced plans to deliver a new supercomputer in 1983, the X-MP, which is two to five times the speed and power of the current model, the I-S, with which the X-MP will be fully software compatible. The price will range from $9 million to $11 million, with additional features costing several million dollars more. Cray has also announced plans for another supercomputer, the Cray II. Work on this model is being conducted by Seymour Cray, who left his management position with Cray in November 1981 and is acting as an independent contractor to the company. The Cray II, scheduled for introduction in 1985, is to be six to twelve times the power of the Cray I-S and cost about $15 million to $25 million. The Cray II is not expected to be able to use the old software without modifications.

- Control Data, the other major supercomputer maker, is about 30 times the size of Cray and supplies a broad line of computers, services, and peripherals. Control Data's Cyber 205, of which eight have been delivered, competes head-on with Cray machines. Both companies claim that their supercomputers are the fastest, but that depends on the type of operations the computer is performing. The Cyber 205, first delivered in 1981, represents an evolution of Control Data's STAR 100 (of which four were built in the early 1970s) and the Cyber 203 (of which three were delivered). Control Data has projected that Cyber 205 shipments will increase to an average of one a month in 1983.

©1983 by INPUT. Reproduction Prohibited.

- The two companies are expected to begin to face further competition for the lucrative supercomputer market. IBM and Sperry Corporation may enter the market in the future, and Japanese manufacturers such as Fujitsu have announced two supercomputers with delivery expected in late 1983. Hitachi also plans to have first deliveries of two supercomputers in the 1983 fourth quarter, and Nippon Electric is expected to announce systems in 1984. Another Japanese government project, anticipated to be 60 to 70 times faster than the Cray unit, is to be available by the end of the 1980s.

5. LARGE MAINFRAME SYSTEM PERIPHERAL DEVICES DEVELOPMENT

- The capabilities of large mainframe computer systems will be affected by continuing developments in mainframe computer peripheral products. Two major types of peripherals affecting mainframes are mass storage devices and terminals, both of which have the effect of increasing computer power and improving the system's ability to meet increasing user needs.

a. Computer Memory Devices Developments

- Computer memory devices can be divided into various types, including magnetic tape, semiconductor, and disk memory. Performance of computer memory devices is measured by storage capacity and access time (the amount of time required to retrieve a piece of data from storage). Magnetic tape systems are the slowest, but cost the least per unit for storage. The slow speed is contributing to decreasing use on-line; however, there are increasing applications off-line.

- Semiconductor memory, located within the central processing unit (main memory) has the fastest access time, but it is also the most expensive. Disk memory falls between tape and semiconductor memory in both price and access time. Thus semiconductor memory capacity comparable to disk memory would be extremely expensive. In general the cost of disk storage in top-of-the-line products has been declining 20% annually, while disk storage

©1983 by INPUT. Reproduction Prohibited.

capacity has been increasing 25%. These characteristics and the rising user needs for storage devices suggest that disk memory systems will enjoy strong growth through the 1980s.

- Disk storage products are made by several manufacturers; however, IBM's products are typically used as a standard for large disk storage devices. At the top of the line is IBM's 3380. IBM's major competitors are Storage Technology, Control Data, and Memorex (a subsidiary of Burroughs), all of whom have products similar to the previous top-of-the-line unit, the IBM 3350.

- New technologies have contributed to improvements in the price/performance ratio of disk drives. The IBM 3380, for example, has four times the storage space and more than twice the transfer speed of its predecessor, the 3350, with prices averaging 25% less than the cost of acquiring the same capacity with the older product. Newer technologies include thin film and vertical recording. Thin film disk heads, which are used on the 3380, increase memory capacity enormously by allowing manufacturers to place more data bits on each track and to squeeze more tracks on each side of a disk. Vertical recording, which stores the data bit perpendicularly instead of laterally to the disk surface, also allows more memory capacity.

- Demand is strong not only for large memory systems, but also for the smaller 8-inch and 5-1/4-inch (hard) disk drives and 5-1/4-inch flexible (floppy) disks. The 5-1/4-inch rigid Winchester disk's growth is propelled by the expanding small business and desktop computers, word processors, and intelligent terminals markets. Seagate Technology is the dominant force in the 5-1/4-inch Winchesters, with Tandon Corporation another important competitor.

b. Computer Terminal Developments

- Terminal developments continue - in particular the availability of additional features to satisfy users' desire for "hands-on" access to information on the terminal, and declining prices.

©1983 by INPUT. Reproduction Prohibited.

- Terminal devices are either "dumb, " "smart," or "intelligent," as classified by their general capabilities. A "dumb" terminal consists of a keyboard, a CRT screen, and a communications line to a CPU (central processing unit). The "intelligent" terminal is the most sophisticated, with many features, including programmability, which makes them very much like a desktop computer. The user can perform data processing tasks independent of a host computer or communicate with the host to utilize its capacity.

- "Smart" terminals have most of the features of "intelligent" terminals except programmability. The line distinguishing these different terminals from each other and from desktops and personal computers (particularly for "smart" and "intelligent" terminals) is becoming blurred with the increasing variety of features being added to the terminals.

- Intelligent terminals have become very popular and should continue their good growth over the next few years. However, this technology is expected to face increasing competition from desktops and PCs, particularly in the OEM workstation area. Several characteristics of the intelligent terminals, such as good communication features and the ability to function well in a distributed environment, make them more attractive than desktops in an office setting. However, the intelligent terminals often fall short in their data processing capacity, which is limited compared with some of the more powerful desktops and PCs.

- The user's needs will ultimately determine whether an intelligent terminal or a desktop/PC will be installed. In the future, as intelligent terminals get smarter and desktops acquire greater communications and networking capabilities, there may be little distinction between the two. All of the large computer system companies make or provide system-compatible terminals; some of the smaller companies in the intelligent terminals market include Convergent Technologies, Zentec, and Ontel. One new trend is the development of PBX- or LAN-based terminals in a fully distributed network environment, with the capability for direct linking to a large mainframe system.

©1983 by INPUT. Reproduction Prohibited.

- In the dumb terminal market, severe price cutting has been prevalent. A number of competitors are competing for a share of the market, through a variety of new product introductions with additional features at lower prices. In general, over the decade it is probable that dumb terminals will disappear, replaced by smart terminals at dumb terminal prices. Important manufacturers in the "dumb" terminal market include Lear Siegler, Applied Digital Data Corporation (a subsidiary of NCR Corporation), and Hazeltine Corporation.

6. CAD/CAM SYSTEMS DEVELOPMENTS

- A special large mainframe systems market is CAD/CAM; integrated hardware/software systems provide computer-aided design and computer-aided manufacturing capabilities.

- The major computer software/services companies in the integrated CAD/CAM systems market include Computervision, Applicon (a subsidiary of Schlumberger), Calma (a unit of General Electric), Intergraph, and Gerber Scientific. The CAD/CAM system provides a full mainframe capability to support the functions of product design, circuit design, and architectural design productivity improvement. An engineer with such a system can produce a product "blueprint" on the terminal screen, make alterations and modifications to the design directly, and then test the design using computer simulation. The time savings involved is enormous.

- The CAD/CAM market, which is expected to grow some 30% to 35% annually over the next five years, should continue to fuel the graphics terminal market. Participants in the graphics terminal market (excluding some of the CAD/CAM companies that have vertically integrated their terminal lines) include Hewlett-Packard, IBM, Tektronix, and Ramtek Corporation.

©1983 by INPUT. Reproduction Prohibited.

- The push by large mainframe system suppliers into the high end of the CAD market has accelerated recently. Apollo Computer entered the market with a 32-bit system supporting interactive and imaging color graphics; Sperry Univac entered the CAD/CAM market with a mainframe-based system in 1983; Digital Equipment entered the engineering workstation market with a system that is linked to its large VAX computers; Prime, after a year in the market, formed a separate division with P&L responsibilities to provide CAD/CAM systems.

- IBM has been developing its position in CAD/CAM. IBM has been marketing Lockheed's CADAM package since 1977 and in the last two years has added four packages, including one written internally. The company formed a direct market group two years ago to support its CAD systems, which are based on its 4300 Series up to the 3081 computers.

- The primary IBM CAD/CAM offerings are built around packages developed by customers and third parties. The company markets a 3D design program developed by Dessault Systems, a subsidiary of the French Aerospace firm; a structural analysis package from Structural Dynamics Research Corporation; a circuit board design program from Bell Northern Research; and an internally developed mapping program. CAD-based system sales for IBM are second only to Computervision in the market.

- Other major CPU suppliers are either acquiring graphics firms or expanding their graphics software capabilities through third-party agreements and joint ventures, thus avoiding the high cost and long development cycles associated with internal R&D efforts. For example, Racal Ltd.'s recent acquisition of privately held turnkey vendor Redac, a Littleton (MA)-based firm specializing in the electrical segment of the CAD market, follows Schlumberger's acquisition of Applicon.

- The CAD/CAM systems present specialized service and support problems because of the intricate hardware/software relationships and the heavy use of

©1983 by INPUT. Reproduction Prohibited.

both electromechanical disk memories and printer/plotters as part of the system. CAD/CAM systems require very specialized support in terms of both installation (including training and documentation services) and continuing services. The use of remote diagnostics, particularly for servicing and applications support, should increase in the CAD/CAM systems market because of the increasingly high cost of providing responsive support services.

B. LARGE-SYSTEM INTERNAL DESIGN DEVELOPMENTS

- A number of developments are taking place with respect to the internal design of large systems. These include:

1. IMPROVED SWITCHING SPEEDS

- In the past, the most noticeable improvement in computer technology has been the increase in computing speed. The ability of a computer to process information faster has an effect on almost every aspect of computing, including cost, size, and versatility. Computing speed, as measured in computations per second or instructions per second, remains the central thrust of most research and development efforts today.

- Yesterday's technological breakthrough was large-scale integration (LSI). That breakthrough desegregated the central processor by utilizing microprocessors to perform mathematical and logic operations. Tomorrow's technology will attain greater computing speeds through the use of faster switching devices and faster memory access. Currently, research and development activities are directed toward at least two methods of improving switching speed: lasers and distributed array processing.

©1983 by INPUT. Reproduction Prohibited.

a. Distributed Array Processing

- An approach to increasing computing speed relies on current technology components but attempts to rearrange the architecture of the computer to gain speed. This approach is called the distributed array processor (DAP). Basically, DAP attempts to eliminate information transfers between computer units (i.e., CPU to main memory) through the use of microprocessors working in parallel. It is felt that by reducing the distance electrons travel, the computation time can be reduced. DAP is the basic approach used in the Cray 1 computer. The distance between electrical components was reduced to the point where the computer could perform 80 million floating point operations per second and could occasionally operate at 140 million operations per second with bursts up to 250 MIPS.

b. Laser Technology

- A technique for improving computing speed may be the use of laser beams. Current research, primarily in England, utilizes laser beams that are refracted as they pass through materials of different densities. Refracting a laser beam will alter the light intensity that, when directed at a crystal, will effectively create an electronic switch. Control of this switch then becomes the means of initiating logical and arithmetic operations. It is estimated that a laser beam optical switch could change states in one trillionth of a second. Thus the switching operation offered by the laser is approximately seven times faster than a switch using Josephson devices.

2. HARDWARE COST REDUCTIONS

- Besides computing speed, mainframe computers of the future will possess another characteristic that is a continuation of past price/performance trends. Decreasing hardware costs or, at a minimum, reduced cost per unit of processing or memory will continue. The ability of computer vendors to continue reducing hardware costs was again demonstrated with IBM's intro-

©1983 by INPUT. Reproduction Prohibited.

duction of the Model 4341, which has twice the speed of a Model 3031 and half its cost.

- Cost improvements will be generated from a number of sources, including faster switching and distributed processing, giving lower cost per instruction, solid state technology, more efficient and larger memories, and even lower development (or prototype) costs. Perhaps the most significant of the above cost factors relates to improved solid-state technology. Not only are new materials providing cost/performance improvement, but new component configurations are also having a similar effect.

- Techniques and component advances have had the result of doubling the number of components on an integrated circuit every year in the 1970s. It is anticipated that a circuit with a cost of $100 per million bits per second throughput (MBPS) will sell for $10 within the next 10 years. This type of dramatic cost decrease is typical of decreases in the 1970s and it appears the trend will continue in computers of the 1980s.

3. MAIN MEMORY IMPROVEMENTS

- Another design area of mainframe computers likely to see continuing dramatic cost reduction and capability improvement in the 1980s is main memories. Depending on a given system's memory requirements, it is possible for mass storage to be the largest single cost component of that computer system.

- Future main memory systems will be based upon emerging technologies such as electron beams, bubble memories, charge-couple devices, holograms, and improved applications of disk memory.

- One technique of improving cost/performance for existing memory systems is to increase the density of data on the face of a disk. It is estimated that a 400MB disk spindle, which is the state-of-the-art today, might contain up to

©1983 by INPUT. Reproduction Prohibited.

four billion bytes in the near future. Another variation in accelerating disk memory access is to use a buffered disk system with an intelligent controller.

- This adaptation of the "cache" system is based on the probability that, once an item of data is accessed, there is an 80% chance that the next data element requested will be within the next four items. As a result, the system brings all five data elements into main memory. Thus, in many applications the sequential processing of a data file may run just as effectively as when the entire data file is core resident. This enhancement reduces processing time and the effective cost of data retrieval. It is also an adaptation of the concept of increasing block size in tape applications.

4. SOFTWARE DEVELOPMENTS

- While the 1980s will continue the trend toward reduced hardware costs or increased processing capacity for the same cost, this does not necessarily mean that full computer systems will be less expensive in the 1980s. Total software costs are increasing, resulting from increased sophistication as well as from rapidly escalating labor costs. However, the impact of increasing software costs, like other facets of computer technology, may be reduced by innovative ideas and advanced technology.

- One approach is to incorporate software into computer hardware. IBM is currently planning this approach through the introduction of an "omnibox" in the mid-1980s. This unit would be an entire system, including the central computer and peripherals, packaged in a box two cubic meters in size. This unit would have many software functions preprogrammed as firmware. While such systems may have limited versatility, the special-purpose software-oriented mainframe computer may also be a trend in the 1980s.

- Past practice has been to design a general or multipurpose central processor and then program the specific job application in order to achieve the desired system. Future mainframes may very well be either microprocessors with

©1983 by INPUT. Reproduction Prohibited.

incorporated hardware to perform a prespecified purpose or a combination of several microprocessors designed to encompass all of a firm's applications processing needs. This may become feasible because a tradeoff exists between decreasing hardware costs and increasing software costs, especially for scientifically oriented applications.

- Under any circumstances, the servicing and support of software in large mainframes will become an increasingly important function. In today's environment, the field engineer is primarily hardware oriented. Software support is provided by technical assistance centers. Increasingly, service engineers must be provided with direct access to this specialized software knowledge while at the job site. One approach is to use handheld/portable computers as a mechanism for software diagnostics and direct access to software specialists.

5. IMPROVED RELIABILITY DEVELOPMENTS

- The five principal techniques used in improving the reliability of large computing systems are redundancy, fault tolerance, failure detection, remote diagnosis and repair, and software recovery after a failure.

a. Redundancy and Fault Tolerance

- Computer manufacturers are hard at work on computers with improved reliability. Tandem Computers, Inc. was built on the concept of full redundancy - the nonstop computer. Tandem's success has attracted competition from Stratus Computer, Inc., of Natick, Massachusetts, which specializes in reliable computers for factories rather than offices. About a dozen other companies are moving into the market for fully redundant systems.

- Systems failures can also be reduced by providing redundancy at the subsystem or component level with backup chips, disk drives, and other parts, so that the computer can keep running even if a part fails. The computers are thus tolerant of faults or "fail-safe."

©1983 by INPUT. Reproduction Prohibited.

- The Stratus computer, for example, has four subcomputers or processors, arranged in two pairs. All four work on the same problem at the same time, and the answers produced by each processor is compared with the answer of the other processor in the pair. If there is a malfunction, the answers within the pair will not agree, and that pair pulls itself out of action, but the other pair continues to work, so the user never notices a slowdown.

- The problem with the use of redundancy or fault-tolerant design in large systems is that it costs extra for four of each part. However, chips are becoming so cheap that the cost impact is becoming less important.

- Tandem uses at least two full system-level processors operating, as the name implies, in tandem. Both processors work on different tasks, but they keep each other up to date on what they are doing so that if one fails, its load can be shifted to the other. While this approach avoids duplication, it has other drawbacks. The time the two processors spend keeping each other up-to-date lessens the time they can spend on other tasks. The processor that picks up the load when its partner fails will slow down considerably, or else must drop some jobs.

- Other manufacturers have developed different approaches. The Synapse Computer Corporation of Milpitas (CA) uses one backup for several processors in the same way that automobiles have one spare tire, not four. August Systems uses three computers at the same time; if one malfunctions and produces a wrong answer, it is "outvoted" by the others.

- As fault-tolerant computers become more popular, traditional mainframe system manufacturers have responded. Both IBM and DEC have announced systems allowing customers to hook two or more machines together in a fault-tolerant fashion. Digital, Wang Laboratories, and others offer guarantees that their computers will operate a certain percentage of the time, usually 95% to 99%.

©1983 by INPUT. Reproduction Prohibited.

- However, the established vendors have shied away from introducing completely new fault-tolerant machines. Most office computer users were not willing to pay the extra price for near-perfect reliability. In addition, as personal computers become more prevalent and people have their own machines, there is less need for a central computer to operate all the time. However, IBM has announced a fault-tolerant, ring-networked configuration of Series/1 computers, and DEC has announced an interconnect structure for sharing processor and storage resources.

- Digital's first implementation employs its DECsystem 20 mainframe line, but the new interconnect structure, based on a high-speed bus, is to be available soon for the company's VAX super minicomputers, PDP-11 minicomputers, and a line of personal computers.

- Meanwhile, Hewlett-Packard in Palo Alto (CA) has announced a dual-processor, host-backup system for HP 1000 model 60 and 65 processors. HP is also working on more advanced fault-tolerant designs for powerful new processors for both the HP 1000 and HP 3000 lines.

- One problem with fail-safe machines is that they deal only with malfunctions in the hardware, not with the more frequent problem of errors in software. Efforts to develop fault-tolerant software are still in the experimental stage. In general they involve having two or more programs written independently to accomplish the same task; the two programs run on separate computers, and then check to see if they agree with each other.

- An operating advantage that falls out of redundant fault-tolerant designs is the opportunity to reduce the cost of maintenance. These costs, which in today's environment may be as much as 15% of the total cost of the system per year, can be significantly reduced in current fault-tolerant designs by eliminating the need for on-call or on-site standby maintenance personnel and by increasing the user's participation in the maintenance process.

©1983 by INPUT. Reproduction Prohibited.

b. Failure Detection

- Since hardware failures are all detected by hardware at the board level, a board can identify itself as failed. This eliminates or at least reduces the need for highly-trained field service technicians to run sophisticated software diagnostics on-site to determine which board has failed.

- The customer can easily remove and replace failed boards. Also, he or she can do this while the system is on-line without any interruption of its operation. Moreover, when a repaired board is plugged into a running system, it is automatically tested and brought on-line by the software without any intervention at all by the operator.

- This type of maintenance package also informs the operator that a failure has occurred. He or she can then either call the customer assistance center and indicate what type of board has failed or else immediately replace the failed board if a spare is in stock at the site. In either case, a replacement board is sent out from the center by overnight courier.

c. Remote Diagnostics Developments

- Improved remote diagnostics and preventive maintenance techniques can serve as helpful adjuncts to redundancy or can even serve as less expensive alternatives for increased reliability. CPU manufacturers are building in circuits that allow service representatives to diagnose malfunctions from remote sites.

- A diagnostic computer at a support center enters the problem CPU via a regular communications line to search for defective circuits. Since the investigating instrument gains unlimited scrutiny of the downed unit, this technique poses a security risk for systems handling sensitive material. For most users, though, the technique can reduce the need for many costly service calls.

©1983 by INPUT. Reproduction Prohibited.

- The typical remote diagnostic scenario described to users is as follows: "Suppose something goes wrong with your system. You call customer services and tell them that you may be able to give them a hint about the problem - a processor has stopped, for example. Immediately an engineer calls up your system and has the diagnostic computer interrogate it through the link, identify the problem area, and dispatch an engineer. On arrival he switches the line to voice, a colleague at the other end is able to tell him that the problem is in (e.g.) circuit board three. He replaces the board with a spare. End of problem."

- Tandem's Nonstop 2 will have built-in diagnostics that will access a system while it's running and report problems to the operator at the console. This will save time, reduce communications requirements, and avoid security problems.

- The newer diagnostics also allow users to stop some malfunctions before they occur. A system might monitor error rates on a disk, detect degradation, and take the disk off-line before it begins losing data bits. In many cases, malfunction causes parts of a machine to slowly "die". Automated diagnostics can identify such situations and alert the service organization to the problem.

- While computer hardware is getting better and better, when it fails the repair technicians or service engineers can't always remember the last time they faced that particular kind of failure. They haven't necessarily had the kind of continual struggle with the problem that would reinforce their training. Sophisticated automated diagnostics using "decision tree" models help recall how a similar malfunction occurred.

- A continually updated data base relating problems and symptoms to probable cause and corrective action is being increasingly used as an adjunct to the remote diagnostic process and as a technique for identifying the need for engineering changes or preventive maintenance actions to improve reliability

©1983 by INPUT. Reproduction Prohibited.

and uptime. In summary, while skill levels of on-site service people vary from the inexperienced to the superexperienced, remote diagnostics can give everyone access to the latest tools, data, and aids.

6. NEW DEVELOPMENTS IN SUPERCOMPUTERS

- Work on supercomputers and advanced artificial intelligence development is also proceeding at a rapid pace.

- Major developments in supercomputers include work at the Microelectronics and Computer Technology Corporation (MCC). Last year William Norris, the founder and chairman of Control Data Corporation, convened a meeting of top computer and semiconductor industry executives at the Grenelefe Golf and Tennis resort in Orlando (FL) to discuss setting up a huge research cooperative. The companies agreed to form a nonprofit joint venture so that they could pool their resources and share the cost of doing long-range research. Twelve major U.S. corporations joined the new organization, including Honeywell, Motorola, RCA, and Control Data.

- The MCC venture partly follows the Japanese model: the companies will donate scientists and researchers to MCC, lending them for up to four years. The consortium will have a budget of about $75 million a year and a staff of 250. Its first projects include programs in semiconductor packaging and interconnect technology; advanced software engineering and computer-aided design and manufacturing (CAD/CAM) for the electronics and computer industries; and a 10-year program aimed at breakthroughs in supercomputer architecture, software, and artificial intelligence. MCC will own the licenses and patents to the technologies; the manufacturing and marketing will be left to the companies that sponsor the projects.

- The Japanese have announced a two-pronged plan to build advanced supercomputer technologies. One project is the $100 million, eight-year National Superspeed Computer project, which aims at producing machines 1,000 times

©1983 by INPUT. Reproduction Prohibited.

faster than the existing Cray-1 supercomputer built by Cray Research of Minneapolis. The other, the $500 million, 10-year Fifth General Computer project, is focusing on artificial intelligence. Both are now being countered by American efforts, including a Pentagon request for up to $1 billion over the next five years for super-speed and artificial-intelligence (AI) technologies. Great Britain and France have also launched national supercomputer projects.

- For their Fifth Generation Computer project, the Japanese are considering a radical departure from the von Neumann architecture, the so-called "data-flow" computer championed for the past 15 years by Professor Jack Dennis at MIT. Dataflow computers will have huge numbers of processors, each with its own memory, and, as in simpler parallel schemes, the computer will have a routing network so that the processors and memories can communicate with each other.

- However, the dataflow computer will go even further, as the rules about when instructions are executed are different in a data-flow-oriented system. Conventional computers process a stream of instructions, one after another, in the order the program tells the computer to follow. In dataflow machines, on the other hand, the processing units don't have to go looking for data in memory; they simply do whatever calculation is necessary when a "data packet" arrives.

  - Cray Research of Minneapolis, one of the world's leading supercomputer manufacturers, is attempting to develop supercomputers with a completely different architecture. Where the Cray-1 had only one processor, the Cray X-MP now coming onto the market has two processors and the Cray-2 due in late 1984 will have four processors. The next machine, the Cray-3, will probably have 16 processors. The Cray X-MP contains a dense pack of 240,000 silicon chips arranged to shorten the distances the electrical signals must travel, thereby decreasing the time it takes to perform an operation; the next Cray X-MPs will run at 400 million operations per second.

©1983 by INPUT. Reproduction Prohibited.

- The HEP supercomputer built by Denelcor, Inc., of Aurora (CO), uses four processors to reach speeds up to 40 million instructions per second.

C. USER ATTITUDES TOWARD LARGE MAINFRAME SYSTEM SUPPLIERS

1. PRODUCT ATTITUDES

- User attitudes toward vendor products based on recent surveys are outlined below.

a. IBM

- IBM users are planning to continue to use equipment from IBM, mostly IBM 308X equipment at the high end, the soon-to-be-announced 4300 replacement at the mid range, and the System 38 or yet-to-be-announced System/36 at the low end. Increasingly, users are moving from lease to purchase orientation, due to recent IBM pricing actions making purchasing more attractive.

b. Burroughs

- Burroughs users appear to be changing their very negative attitude toward the company as the newer products (900 series) have rolled out. However, Burroughs will have to maintain its product development momentum, thus shortening the life cycles of existing products (the B900 and B7900, for example). Nevertheless, the company appears to be in a recovery period.

©1983 by INPUT. Reproduction Prohibited.

c. Honeywell

- Honeywell large-system users appear to be increasingly interested in other vendor options. There appears to be little demand for Honeywell's top-of-the-line DPS 88 and a winding-down of the DPS 8. The main interest is in the mid-line DPS C/Level 6 systems. This user trend must be halted.

d. NCR

- NCR users appear to have a growing dissatisfaction with existing mainframe products. While there may be a good reception for the recently introduced 9300 series and the expected 9500 line, it remains to be seen whether NCR can continue to be competitive in the large mainframe systems market.

e. Sperry Univac

- Sperry Univac users, particularly on the government side, appear to be positive. However, the commercial/industrial markets are less enthusiastic about the 1200/90 systems line. In addition, in general most users are dissatisfied with the fragmented product lines and the inability to efficiently migrate upwards.

f. IBM Plug-Compatible Systems Users

- IBM plug-compatible mainframe users, primarily those concerned with cost and with knowledgeable MIS systems staffs, are satisfied. There are now seven vendors selling almost 50 IBM lookalikes, with more announced every month, including Amdahl, Formation, Four Phase Systems, IPL, National Advanced Systems, and Nixdorf. Generally, these systems have a better price/performance ratio, higher reliability and easier repair, and are physically smaller than the IBM equivalents.

©1983 by INPUT. Reproduction Prohibited.

- However, because of their small organizational size and installed base, the IBM plug-compatible vendors do not have strength in hardware and software maintenance and repair, and when such companies run into technical problems (e.g., Magnuson), the service and support force simply can't handle the job efficiently. IBM has introduced a number of strategic moves aimed at the plug-compatible vendors, including staggered introduction of product features causing the other vendors to continually upgrade and modify their equipment, timing of new product announcements, lowering of product prices, and aggressive pricing of SCP-classified operating software.

2. USER ATTITUDES TOWARD LARGE-SYSTEM VENDOR SERVICE

- In general, large-system users are usually satisfied with service performance in the initial installation period (i.e., relative to environment planning, physical site planning, consulting, documentation, training, and installation planning) and at phase out (site audits, relocation, and deinstallation).

- A few vendors (Burroughs, NAS, and Univac) appear to have customer problems with installation. Only Cray and Tandem have customer problems with respect to phase out or removals.

- Surprisingly, the major problems with large-scale users is relative to ongoing service (particularly in hardware and software maintenance), where there is a high degree of customer dissatisfaction across the board, as shown in Exhibit III-3.

- As indicated in the survey, hardware response time in general appears effective relative to customer requirements except for Sperry Univac and Perkin Elmer. However, software response time is generally not as good as customers require, as shown in Exhibit III-4. Most vendors are not meeting customer requirements for software response under critical (software inoperative), operational (software degraded), or partial (mildly degraded) situations. This is particularly true for Burroughs and Univac.

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT III-3

LARGE-SYSTEMS DISSATISFACTION WITH KEY SERVICES OFFERED BY VENDOR*

(Percent Expressing Dissatisfaction with Level of Services Offered Compared to Requirements)

SERVICES	VENDOR												
	Amdahl	Burroughs	CDC	Cray	DEC	Data General	Honeywell	IBM	NAS	Perkin Elmer	Tandem	Sperry Univac	Overall
Installation Planning	20.6%	46.4%	29.2%	40.0%	36.7%	33.3%	27.2%	20.8%	26.7%	20.0%	20.0%	35.5%	28%
Documentation	41.1	53.5	37.5	30.0	36.7	52.4	66.7	35.9	46.7	55.0	20.0	54.8	45
Training	38.2	53.5	37.5	50.0	30.0	33.3	36.4	35.9	46.7	40.0	40.0	45.1	38
Hardware Maintenance	55.9	60.7	58.4	40.0	46.7	47.7	57.6	33.9	40.0	50.0	50.0	48.3	44
Software Maintenance	52.9	53.5	45.8	50.0	56.6	61.9	57.6	56.6	46.6	65.0	40.0	58.1	56
Relocation	20.6	25.0	12.5	10.0	33.3	23.9	15.1	15.1	23.3	40.0	50.0	25.8	20
Deinstallation	29.4	25.0	12.5	30.0	36.7	14.3	21.2	20.7	13.3	20.0	20.0	25.8	20

* Based on 1983 INPUT Survey of Users

= Highlights Majority

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT III-4

HARDWARE AND SOFTWARE RESPONSE TIME*

(Required versus Actual Mean Time in Hours)

	HARDWARE RESPONSE TIME		SOFTWARE RESPONSE TIME					
			SOFTWARE INOPERATIVE		SIGNIFICANTLY DEGRADED		MILDLY DEGRADED	
	Required	Actual	Required	Actual	Required	Actual	Required	Actual
All Vendors	1.78	1.68	2.51	3.17	6.40	8.39	26.64	38.01
Amdahl	1.38	0.99	1.07	0.63	1.30	1.03	12.55	7.42
Burroughs	1.10	0.82	1.20	1.22	2.59	5.04	6.77	7.14
CDC	1.40	0.89	2.22	0.62	6.22	5.42	6.44	5.30
Cray	0.68	0.61	0.32	0.48	0.48	0.48	0.18	0.18
DEC	2.15	1.84	7.50	2.44	12.60	14.10	89.94	43.72
Data General	2.98	2.25	2.65	2.90	2.75	2.38	49.50	85.50
Honeywell	1.45	1.36	1.06	1.01	2.69	5.39	7.13	6.78
IBM	1.22	0.72	1.26	3.75	10.21	10.94	20.36	19.58
NAS	1.17	0.75	0.95	1.33	4.73	4.73	15.01	12.37
Perkin Elmer	6.65	7.20	11.88	19.75	3.00	13.50	53.83	48.50
Tandem	1.30	1.00	1.88	2.38	1.60	2.00	5.00	5.00
Univac	1.20	1.21	1.42	2.46	15.14	20.75	26.28	57.59

* Based on 1983 INPUT Survey of Users

= Highlights Insufficient Response.

©1983 by INPUT. Reproduction Prohibited.

- The high percentage of third-party maintenance users among large-systems users is an indication of the growing dissatisfaction with hardware and software maintenance services.

  - Thirty-one percent are now using third-party maintenance for some part of their equipment base. The highest percentage of third-party maintenance is among Burroughs, CDC, DEC, Data General, and Tandem users.

  - Several user segments, such as IBM, DEC, Amdahl, Data General, and NAS, are considering either third-party maintenance or a general management contract.

D. THE LONG-TERM FUTURE OF LARGE MAINFRAME SYSTEMS

- The long-term future and importance of large mainframes is influenced by competition from superminis with higher price/performance ratios and from fully distributed PCs. The key element in the future role of mainframes is the ability to provide and control general access to large data bases, and to offer efficient data management systems. The development of advanced local-area network (LAN) technology in general and mainframe interface server efficiency in particular will support this change.

- The next two years will see major inroads, with most progress seen in the technology of fully distributed data processing modules, such as workstations, and through LANs. Within five years the technology could be fully developed and price effective, such that mainframe systems are reduced to the role of maintaining current programs. In 10 years' time, with the exception of large supercomputers, the large commercial standalone mainframe system will have ceased to dominate the installed base, superceded by distributed processing systems.

©1983 by INPUT. Reproduction Prohibited.

I. TECHNOLOGICAL AND COST/EFFECTIVENESS ISSUES

- The problem with current large mainframe systems is that, with the growth of interactive processing, one hardware unit is being subdivided by software into multiple logical machines. Sharing a CPU when CPUs are cheap is, to a user, more and more difficult to accept. Thus, the micro invasion has started from the large system's weak spot.

- Emulating conventional IBM terminals on microcomputers is relatively easy. Straight 3270 emulations only offer cost advantages; protocol converters that emulate a 3274 controller but use ordinary RS 232 async terminals instead of 3278 coax cables are more interesting since they provide efficient access to the large mainframe system for a wide variety of terminals.

- In essence, the use of a micro as a terminal emulator creates the possibility of additional local processing. The initial approach will be to use a multitasking workstation and run the emulator as one of the many tasks. Next will be the development of file transfer software via the 3270 emulation. Unlike RJE (3780) emulation, this is not easy since there is no equivalent mainframe spooler support. Thus, there will unfortunately be a variety of protocols dictated by the mainframe support software.

- Once this technology is fully developed, however, the opportunity for a significant reduction in the role of the mainframe system increases. The next product developments (i.e., by 1984-1985) will provide record access to the mainframe files, using new protocols that allow a micro emulating a 3270 to execute local programs using mainframe data and/or local data in a standard micro program. Then all application programs (even the largest ones) can be developed and run at the workstation, with the mainframe being relegated to the role of data base manager.

©1983 by INPUT. Reproduction Prohibited.

- Examples of such interface programs are now being developed by suppliers of proprietary mainframe software. For example, Peachtree's micro software accesses MSA's mainframe ISAM files. VisiCorp's VisiAnswer package allows asynchronous access to Informatics' data base files for local VisiCalc processing.

- These are only a few examples. What will be ultimately recognized and developed is the general-purpose large mainframe system package, with a defined protocol that all micro manufacturers can support, which will give access to any data base software. This concept will be extended to LANs with a special purpose mainframe interfacing server, so that all users can access the mainframe data.

- Present supporters and users of large mainframe systems will argue that this evolutionary trend will not occur because the mainframe is still required for multistream batch processing, particularly major jobs often done overnight or on weekends. However, even this processing requirement could be accomplished by adding a number of single-stream microprocessor-based dedicated batch processing servers on the LAN, each using the next generation of LSI processors.

- Certainly the present general mainframe architecture is not right for an optimized dedicated data base machine. One 500 MB drive has one head mechanism; five 100 MB 5-1/4-inch Winchesters have five heads, so that with proper distribution of the data, much improved performance will result. Parallel searching of drives is possible, necessitating specialized processing hardware with the accent on content addressability and parallel processing. Such data base machines with highly integrated, specialized hardware and software are already on the market. These, and not mainframes, are the machines best suited to take advantage of multiple drives.

- However, it is important to recognize that the future path and role of the large mainframe system is, to say the least, a subject of debate. While one

©1983 by INPUT. Reproduction Prohibited.

argument postulates that the evolution of micro technology will eventually force the large mainframe system into a lesser role, a countering argument holds that this same development will cause the mainframe market to progress rapidly, providing data base and network control to corporate users. The same LSI and VLSI technology that has fueled the growth of micros, PCs, and networks can obviously also lead to further technological improvements in mainframes, providing them with additional computational capabilities and opening up new avenues for their application.

- Taking this scenario, it is possible to forecast that the overall U.S. large mainframe systems market will grow at better than 4% a year for the next dozen years - a $16.8 billion market by 1995, the year by which some experts predict large mainframe systems will have perished. By way of comparison, U.S. mainframe sales stood at $10.5 billion in 1982.

2. MARKET SEGMENT ISSUES

- It is clear from surveys of the market that some user segments will continue to depend heavily on large mainframe systems.

- The banking industry, for example, will continue to be a large contributor to the continued use of the mainframe computer systems. Those mainframe system manufacturers serving these markets (i.e., Burroughs and IBM) should over the next decade maintain about the same market share they have now. The banks constitute about 22% of the total mainframe market, a share that should rise slowly in the next few years. However, this rate of growth will fall off as automation efforts come to fruition. Nonetheless, late in the decade, a large replacement market is expected to emerge, again boosting the relative positions of the banks in the mainframe market.

- Another traditionally strong user area of large mainframe systems, manufacturing, is also expected to grow substantially in the next 10 years and especially in the next two or three years, as companies pull out of the recession

©1983 by INPUT. Reproduction Prohibited.

and automate their manufacturing facilities. This is particularly true for the large continuous process manufacturers (i.e., chemical companies), as opposed to discrete process manufacturing.

- Other traditional mainframe users, such as services and the government, are expected to continue using mainframes, but with virtually no growth or decline. Wholesale and retail trade companies, which traditionally have not been heavy mainframe users, are expected to begin to use larger systems over the next decade as the predicted new technology drives down the cost and increases the power of the large computer systems.

- In summary, a key trend in large mainframes suggests the need to develop market segment/niche-oriented service and support strategies. This would involve the establishment of capabilities to provide installation, maintenance, and support services directed toward the particular/unique service requirements of banks, continuous process manufacturing, organizations, government, etc., with special response/repair time commitments and service product portfolios.

- For example, the ability to install, service, and support automatic teller machines (ATMs) and teller automation (cash-dispensing stations) would appear to be an important issue in establishing the viability of a service organization in the banking market, as banks move to fully integrated and automated operations. The ability to fully provide telecommunications and data processing support services in government markets is becoming more important to those users.

©1983 by INPUT. Reproduction Prohibited.

E. CHANGING REQUIREMENTS FOR SERVICE MANAGEMENT AND SUPPORT OF LARGE SYSTEMS

- Of great importance and challenge resulting from the changing role of large systems and the increasing proliferation and integration of office automation and telecommunications products as an integral part of a large-system controlled network is the emerging requirement for overall integrated service management. Users are increasingly interested in a single organization that can handle the array of problems generated by the installed base of large mainframes, office automation, and telecommunication products supporting their operation. These requirements stem from the need to:

  - Avoid finger pointing - provide a single source of responsibility for service.

  - Provide overall management of service response and repair times.

  - Provide service cost containment.

- As an indication of this emerging requirement, an increasing percentage of users are either currently using, or are considering using, third-party maintenance service organizations.

- Service management provides the ability to deliver total service on a controlled basis for the various information technology products, and is being developed as an alternative service delivery mechanism by several major service organizations. There appears to be interest in this concept, particularly by large-system users with integrated office systems composed of multiple-vendor units or products.

- In essence, there are a number of new challenges being created as a result of the technological developments in large systems relative to:

©1983 by INPUT. Reproduction Prohibited.

- Increasing capabilities and functions for fault tolerance and remote diagnostics.

- Overall integration as part of network-controlled systems and very large supercomputers.

- Growing interdependency and networking of products with the large mainframe forming a key connecting mechanism for both centralized data and communications control.

- Increasing use of very high speed LAN and integrated voice/data PBXs tying large mainframe systems to individual office automation products in a single network.

- These challenges can be categorized in terms of:

  - Changes in user requirements, creating the need to be increasingly responsive and more efficient.

  - Changes in attitudes toward alternative service delivery mechanisms, with particular emphasis on remote diagnostics and preventive maintenance. A need is created for a full portfolio of service alternatives and products to meet individual user service needs.

  - Changes in users' view of viability of service management and third-party maintenance, creating the need to manage service totally and to reduce the focus on specific products, or to focus on self-manufactured products only (recognizing the user's need for total management of service response).

  - Changes in service needs due to the requirements of integrated, interconnected, fully distributed systems.

©1983 by INPUT. Reproduction Prohibited.

F. TRENDS IN SERVICE MANAGEMENT TECHNOLOGY

- Increasing emphasis is being placed on more effective management of service on a centralized basis. This has involved the development and implementation of computerized systems for:

1. SERVICE CALL HANDLING AND DISPATCH

- Providing capabilities for centralized handling and processing of service calls to include identification of customers, call-up of equipment information on customer site, assigning service engineer, tracking the call, and call closeout.

2. REMOTE DIAGNOSTICS/TECHNICAL ASSISTANCE

- These capabilities provide for screening and processing of received service calls to determine problem cause and to attempt a "fix" in conjunction with the user to avoid an on-site service call. For large, remotely diagnostic equipment systems, this also involves remotely diagnosing and repairing equipment via phone line interchange, or at least introducing limited hardware and/or software "patches" or fixes, until a service engineer can be dispatched. This also includes the ability to provide software "fixes" or to support remotely.

3. ORDER PROCESSING/INVENTORY CONTROL

- Providing capability for controlling the material/logistics pipeline of whole units, components, parts, materials, and supplies from control warehouses and depots down to and including the field engineer trunk level. Typically, these systems provide for emergency reorder, maintenance of stock levels to achieve a given fill rate, and tracking of returns.

©1983 by INPUT. Reproduction Prohibited.

4. RETURN/REHABILITATION CONTROL

- Systems are now being developed independently, or as an extension of basic inventory control systems, to control the return rehabilitation process in order to control the fill material/logistics pipeline. This is particularly important in support of large systems, where a pull-and-replace module maintenance philosophy tends to create increasing demand for more investment in the logistics pipeline. Increasing the rate and efficiency of the rehabilitation cycle can reduce total inventory acquisition needs.

5. DATA MANAGEMENT AND REPORTING

- Providing capabilities for managing data associated with failure rates, response and repair times, costs, time utilization, etc. by geographic service area, product group, customer class, etc. and providing standard and exception reports. Typically, such capabilities include the ability to generate exception or alert reports if service call response and/or repair times exceed certain thresholds. The ability to manage, track, and control this data is particularly important in support of remote diagnostics and fault-tolerant systems support.

6. INVOICING AND BILLING

- Providing capabilities for automatically generating invoices and cost allocations based on completed installation and service calls, and the ability to allocate costs by product, customer class, geographic area, etc.

7. OTHER NEW SYSTEMS DEVELOPMENTS

- Work is now being done to develop capabilities for:

  - Installation planning and scheduling.

  - Preventive maintenance scheduling.

  - Changes, upgrades, and removals scheduling and planning.

©1983 by INPUT. Reproduction Prohibited.

- This is particularly important in managing large-systems projects and site support. Typically, most service organizations control and plan installation and preventive maintenance on a regional basis. Special site or customer-oriented systems are required to effectively plan, control, and schedule installations, moves and changes, upgrades, PMs, and removals for large systems to take into account the specific configuration involved and customer requirements.

- In addition to service management systems developments, major service organizations are developing technology for:

  - Automated or semi-automated board testing.

  - Controlled rehabilitation and rework systems using MRP and scheduling technology.

- Finally, considerable work is being done on the development of product-based modules for direct circuit testing and recovering, enabling modular pull and replacement in case of failure, remote diagnostic interface with central TAC or Diagnostic Centers via telephone, and built-in backup and recovery hardware and software capabilities via redundant or fault-tolerant circuits or self-diagnostics.

G. BALANCING RELIABILITY, RESPONSIVENESS, AND PRODUCTIVITY TOOLS

- To a large extent, most large-systems service and product organizations fail to effectively balance reliability, service responsiveness, and productivity goals and objectives due to a number of reasons:

©1983 by INPUT. Reproduction Prohibited.

1. LACK OF AVAILABLE DATA ON EQUIPMENT FAILURE RATES, REPAIR TIMES, ETC.

- Most service organizations do not track or report on such key factors as mean time between failures (MTBF) and mean time to repair (MTTR) by product or cause.

- In addition, most service organizations do not measure service costs or productivity by product to evaluate the effect (on service repair times and productivity) of alternative reliability levels, the use of built-in test equipment, or design modularity. As a result, even basic information on reliability, maintainability, and repairability is lacking, inaccurate, or not available in useful form.

- Only a few of the large-systems service organizations have developed formal methods for relating problems to causes. Few have taken corrective action as to how this data is used in future diagnosis and repair. As a result, remote diagnostics and on-site repair time and processing can be significantly improved.

2. LACK OF FORMAL RELIABILITY, AVAILABILITY, AND SERVICEABILITY (RAS) DESIGN CONSIDERATIONS IN INITIAL PRODUCT DEVELOPMENT CYCLE

- The problem of not effectively managing, from a service standpoint, the tracking and controlling of problem/symptom and cause/corrective action data by product, is compounded due to the lack of effective mechanisms for tracking of MTBF/MTTR data for new products or evaluating the need for engineering and design modifications and changes for products with an unusually high field failure rate.

- In essence, there is a trade-off to be made for each product. The trade-off must relate product price, product reliability, and service supportability. For each individual product, there is a crossover point where it is less expensive,

©1983 by INPUT. Reproduction Prohibited.

on a per unit basis, to provide after-sale service to a product in order to achieve a given uptime, than it is to add more redundancy or initial field engineering changes to improve inherent reliability and extend the product MTBF.

- Many large-systems service organizations are establishing product management organizations within the service group to:

  - Track MTBF and MTTR data by product.

  - Manage product service and support costs.

  - Provide direct input into new product design decisions (to support the reliability/maintainability trade-off analysis).

  - Recommend and control field engineering changes and modifications to improve the overall efficiency of service.

  - Identify critical product design problems from a service standpoint and formally alert the field service and technical assistance center as to what actions to take.

- In essence, it is essential to manage product design reliability versus service response and repairability on a continuing basis. This requires data on product failure rates by cause and a dedicated and committed product management group.

- In summary, major trends in service technology affecting the reliability/responsiveness balance for large systems include:

  - Increasing use of fault-tolerant circuits and design.

©1983 by INPUT. Reproduction Prohibited.

- Ultrareliable modules and worst-case design are being increasingly used in large systems to increase uptime and reduce the probability of total system failure.

- Duplexing and redundancy, other approaches that are used strategically by some of the major vendors (e.g. Tandem), utilize redundancy to increase reliability and uptime.

- Better management of MTBF and MTTR data to predict future failure rates and to manage and control the product support life cycle.

©1983 by INPUT. Reproduction Prohibited.

IV NEW DEVELOPMENTS IN SERVICE MANAGEMENT AND TECHNOLOGY

IV NEW DEVELOPMENTS IN SERVICE MANAGEMENT AND TECHNOLOGY

A. INTRODUCTION

- Considerable work is being done to improve the reliability, maintainability, and supportability of large mainframes. This includes work and development in remote diagnostics, user self-maintenance, and field and depot test equipment. New service products approaches are also being developed. A brief summary of major developments is outlined below.

B. REMOTE DIAGNOSTICS

- Remote diagnostics is becoming more prevalent and will be a basic requirement for all large mainframe systems by 1985. Remote diagnostics is already used in network processing equipment, where practically no modem or multiplexer or network node control is designed anymore without remote diagnostics built in. Major mainframe computer companies have been planning and implementing remote diagnostics long enough that some leaders are emerging. AT&T and IBM have been farsighted in their offerings, along with Burroughs, DEC, Honeywell, Data General, and others.

- Remote diagnostics presents opportunities for computer mainframe manufacturers to increase profits in service areas. Remote diagnostics can also be used as a marketing tool synonymous with truly advanced products.

©1983 by INPUT. Reproduction Prohibited.

- Most computer manufacturers are significantly underestimating the premiums that users are willing to pay for new products that include self-diagnostic and remote diagnostic features. Market surveys indicate that users express a willingness to pay some premium for a remote diagnostics capability; particularly if it can be related to improved responsiveness and uptime, and to reduced on-site repair time. Increasingly, users are expecting that remote diagnostics will be available as a part of the system and/or services offering.

- Special vendor developments in remote diagnostics are outlined below.

1. IBM DEVELOPMENTS

- Remote diagnostics has produced some impressive results for IBM. IBM's Field Engineering Division says remote diagnostic support assists in providing customers with both hardware and software service. IBM has found that the principal advantage of remote support is quicker turnaround time for problem identification and resolution. For hardware, IBM customer engineers have access to an on-line data base containing reported problems and solutions.

- IBM customer engineers can also connect specific products directly to specialists in IBM product support centers. Specialists at the centers may execute diagnostic tests as if they were on the scene at the customer location, and provide direct diagnostic assistance to the on-site IBM customer engineer. Under a maintenance contract IBM, and not the customer, has responsibility for maintaining IBM equipment; thus, unlike several other vendors, IBM does not offer remote diagnostics as a separate service to customers for large mainframe products.

2. HEWLETT-PACKARD DEVELOPMENTS

- Remote diagnostics plays an important role in Hewlett-Packard's recent offering of 99% guaranteed uptime service on its new HP 3000 Series 44

©1983 by INPUT. Reproduction Prohibited.

computer. Among the features that led to the offer is a new, smart control and maintenance processor that makes extensive diagnostics available and remotely accessible. The functions and responses are available remotely by telephone for maintenance purposes.

3. AMDAHL

- Amdahl Corporation is another firm that relies heavily on the use of remote diagnostics to provide service. The firm was one of the first to build remote diagnostic capability into large-scale systems. Rather than place remote diagnostic equipment in all local offices, Amdahl has opted to place these systems in two locations in the U.S.

- Most users dial up these support centers directly. Most problems actually involving a service dispatch are with peripherals or applications, since the remote diagnostic capability assures that the CPU hardware is highly stable. Improving stability and reliability of the CPU hardware was one reason Amdahl decided to build remote diagnostics into its equipment from the beginning. Amdahl has cross-trained its field maintenance personnel so that all service engineers provide both hardware and software maintenance, with assistance from remote diagnostic/TAC facilities.

4. SPERRY UNIVAC

- Sperry Univac has a well-developed centralized remote software maintenance program staffed with 20 people running out of its Roseville (MI) office. Although software service is still delivered on a local basis, remote diagnostics lends itself to a central approach. Univac keeps a central data base of all known software problems and corrections for its systems. This data is available through call-up to the central software facility. Sperry Univac has not developed full capability for large-systems hardware remote diagnostics.

©1983 by INPUT. Reproduction Prohibited.

5. HONEYWELL

- Honeywell has been offering remote diagnostic support (called TACDIAL) for its medium- and large-scale systems for several years. TACDIAL provides parallel remote access to both console visual display terminals and control panels. This remote diagnostic access capability gives users the option of performing interactive system diagnosis remotely as well as on-site.

- TACDIAL is part of Honeywell's Systems Control Facility, which consists of a logic board and related interconnect cables and minibulkhead. The logic board plugs into a reserved Megabus slot in the central system of DPS 6/90 computers. Honeywell said either MOD 400 Release 2.1 or MOD 600 Release 2.0 operating systems are required to support the diagnostics capability.

- TACDIAL capabilities include operator error detection, operations assistance, customer-written applications support, and media analysis. One TAC is located in Newton (MA) with another based in Phoeniz (AZ). The TAC centers can be accessed directly or via Honeywell's centralized call-handling and national response center located in Atlanta (GA).

C. USER SELF-MAINTENANCE AND INSTALLATION

- Another development among large systems is a growing interest in self-maintenance to reduce service costs and increase responsiveness. There are four areas where the large mainframe user can directly participate in maintenance. These are equipment installation, diagnostics, actual maintenance, and return of defective parts to a depot. Users are generally responding more positively to the self-installation and diagnostic aspects of the offering, and less positively to the depot maintenance aspect.

©1983 by INPUT. Reproduction Prohibited.

- Approximately half of large-mainframe users perform their own diagnostics and a third will install or are willing to consider installing equipment. Depot and hardware maintenance are both resisted by the great majority of large-system users.

I. USER REPAIR

- Taking care of simple equipment such as terminals does not seem to be a problem for most users. Less than 5% are currently willing to service mainframes, and only 10% will work on minicomputers. However, more technically advanced market sectors - banking, education, and manufacturing - expressed willingness to do self-maintenance with the appropriately supplied tools and techniques (training, documentation, technical assistance, etc.)

- In the long run, most users indicated that the only real hope to reduce maintenance costs lies in designing systems that eliminate as many maintenance considerations as possible through redundancy and fault tolerance, or lies in simplifying maintenance through straightforward pull-and-replace repair philosophies and designs.

- Through these techniques the need for regularly scheduled preventive maintenance on IBM data processing products has been reduced significantly. IBM's goal is to ultimately have products requiring no routine preventive maintenance. Toward this end, IBM is relying on predictive analysis to define the maintenance actions needed on the products serviced. Using a combination of on-line or concurrent techniques and user maintenance-based actions, the necessary maintenance is providing minimal interruptions to the availability of the customer's system.

- However, several organizations are developing products that reduce preventive maintenance actions on the part of the customer, focusing on simple customer action in the event of partial or full failure. Sperry Univac is developing products that tend to deemphasize the customer doing PM. Sperry

©1983 by INPUT. Reproduction Prohibited.

Univac's long-range plan is to get away from preventive maintenance and to design products that won't require it. Several factors can be combined to drive this plan at Sperry Univac. These include more reliable technology, the costly labor spiral, and safety requirements that make customers keep away from working inside the cabinet.

2. USER INSTALLATION

- Sperry Univac is placing greater emphasis on user-based installation and first level problem identification and resolution. Univac has a new terminal line designed for direct customers to set up. Part of this program includes customer diagnostics and subsequent returning of the part or all of the terminal to a repair center. In this product area, as the technology brings size down to where part return is possible, Sperry Univac will offer less expensive forms of maintenance. Univac is working toward customer installability of all future product lines. The approach is to let customers get involved if they desire, but not to force them. This is part of a strategic move toward increased customer participation and reduced service costs.

- In order to further reduce maintenance costs for both itself and customers, Honeywell introduced a Customer-Assisted Maintenance Program (CAMP), which at this time is limited to its VIP7300 line of terminals. All models of the VIP7300 family are not only user installable, but are designed with modules that the customer can replace by following step-by-step, nontechnical illustrated instructions. This helps assure maximum equipment availability without the customer having to call a Honeywell field service representative. Should additional customer-replaceable units be needed, users can receive them from Honeywell, often within 72 hours.

3. BOARD SWAPPING

- Another user-oriented service strategy being developed is board swapping, whereby a trained systems user removes an ailing part from the computer and

©1983 by INPUT. Reproduction Prohibited.

immediately replaces it with a working unit. This strategy is popular with a small group of users for a number of reasons:

- Most companies are so fully tied into their computer systems that even the slightest downtime can cost thousands of dollars in lost processing time and delays. Therefore, the machines have to be up and running as soon as possible.

- Today's entry-level field engineers are not as skilled as their counterparts were six or eight years ago. Thus, board-level fault identification and exchange has to be simplified so that it can be accomplished by a trained user.

- Most service organizations are willing to supply a set of on-site spares or boards or resupply them quickly at a price lower than full on-site service.

- A major drawback of board swapping by either the user or the service organization is that it is expensive. The total cost of sending out an engineer to replace a bad board, including diagnosis, replacement, retesting the system, and sending the board back to be repaired, costs about $500. Adding to this cost misery is the fact that from 30% to 50% of the boards sent back to a repair depot actually prove to be good after proper testing. Thus, a significantly greater logistics pipeline is required as a result of a board swap support strategy, unless the depot-level repair/rehabilitation process is effectively managed and controlled.

- In the past few years both users and vendors have come up with a new approach that not only decreases the maintenance cost, but reduces the downtime. Many large users have purchased portable board testers to do their own periodic system checks and minor maintenance. The testers are usually programmable, intelligent, and easy to operate. Using these devices, a firm can isolate bad boards and plug-in spares that are on hand. The bad board can then be sent back to the manufacturer for repairs.

©1983 by INPUT. Reproduction Prohibited.

- Board vendors are aiding this self-help program by "socketing" the parts - such as the actual chips - on a board. By socketing specific board parts, the whole device does not need to be replaced or tied up in a repair shop. Vendors are also providing boards with more built-in maintenance and diagnostic lines to facilitate the use of portable testers by users.

4. DEPOT REPAIR CENTERS

- Taking advantage of depot repair centers is another way users are cutting down on maintenance costs. Nearly every equipment manufacturer has a remote center located off-site from the main manufacturing facility. These centers, which are primarily used locally by the vendor's engineers, are usually fully stocked with testing equipment and repair parts, much like the service departments of new and used car dealerships. Defective computer parts can be brought into a service depot for repairs and new ones picked up as substitutes.

D. FIELD AND DEPOT SERVICE TEST EQUIPMENT

- New developments in field service test equipment include:

1. ON-SITE PORTABLE AUTOMATED FIELD SERVICE TEST EQUIPMENT

- The GENRAD 2620 field maintenance processor and the 2630 system test status unit are examples of portable test units. The 2620 field maintenance processor combines a 34-pound, scope-like package with enough computer power for on-site field service and program preparation. The 2620's central processing unit, a Z80A-based microcomputer, is equipped with the standard 256 K-bytes of memory. It is priced at $9,995.

©1983 by INPUT. Reproduction Prohibited.

- Particular emulation and measurement subsystems for the unit to be tested are accommodated by a universal adapter bus, accessible from four plug-in slots on the tester's side panel. To ensure system flexibility and to support future software enhancements, all system utilities are loaded into internal random-access memory from a 5-1/4-inch disk drive.

2. DEPOT-LEVEL AUTOMATED TEST EQUIPMENT

- Hewlett-Packard has created a powerful digital repair tool for depot-level use: the HP 55005A logic-troubleshooting system. In its basic form, the tool consists of an HP 5005B programmable signature multimeter, an HP 85 desk-top computer, and the software necessary to knit the two together. The bundled basic system is priced at $9,675.

- The logic-troubleshooting system's semiautomation of the signature-analysis procedure represents an optimized bridge between $1,000 manual signature analyzers and the full automation of signature analysis and backtracking represented by $100,000 board testers. The instrumentation is in effect a knowledge-based system, acting with the kind of artificial intelligence that previously had been available only in large test systems in the quarter-million-dollar price range.

E. NEW SERVICE PRODUCT DEVELOPMENTS

- In addition to the above technological developments, work is being done to improve and expand service product agreements. These developments are outlined below.

- There has been a significant change in the level and availability of maintenance and support options, particularly for large mainframe system service suppliers.

©1983 by INPUT. Reproduction Prohibited.

1. TIME-OF-DAY AND DAY-OF-WEEK COVERAGE

- IBM's customers have the flexibility of being able to select a nine-hour, Monday through Friday maintenance service availability that corresponds to when an IBM system will have its heaviest use and greatest need for service. This service is included in the monthly lease charges.

- If the customer requires additional IBM service outside the nine-hour period, it will be delivered in one of two ways selected by the customer. In the first instance, the customer pays a fixed monthly rate outside the prime-shift period. The customer's second option is to pay for IBM service performed outside the nine-hour period at an hourly rate. The service options are designed to give the customer a wider range of choices in deciding how maintenance is to be performed.

2. GUARANTEED UPTIME

- Guaranteed uptime is another feature offered by several vendors. For example, 99% uptime is among several maintenance agreement programs offered to HP 3000 Series 44 purchasers. Under the terms of this agreement, uptime of the system's critical elements will be evaluated monthly for the previous three months and a month's service credit for the products covered will be given if 99% uptime specifications are associated with 24-hours-per-day, seven-days-per-week coverage.

3. LEVELS OF SERVICE RESPONSE

- Several firms now offer users cost savings on premium service options for different levels of response. For example, most service organizations used to have only one level of response time - four-hour, same-day service - but now users can opt for next-day service and receive a 25% savings over the same-day service option. Alternatively, they can receive one- or two-hour service, at a premium of 25% to 50% over same-day, four-hour service.

©1983 by INPUT. Reproduction Prohibited.

4. REMOTE DIAGNOSTIC SERVICE

- Several firms are also directly providing users with up-to-date maintenance techniques, such as remote diagnostics. Remote diagnostics was originally used as a phone dial-up service for consulting on hardware and software problems by field technicians. However, several companies have since expanded this use, building remote diagnostic capability into the large systems and offering the user remote diagnostics at the user's own site (for multiuser sites and for self-maintenance support).

5. GENERAL SERVICE-LEVEL AGREEMENT SPECIFICATIONS AND MEASUREMENT

- Service-level agreements represent a method of assuring adequate support from the service operation of a manufacturer or third party. These agreements are becoming more popular. Frequently users put out requests for procurement that specify a level of service, usually in terms of percentage of uptime, response time on terminals, etc. It is not unusual for an RFP to demand information about mean time between failures and sometimes mean time to repair - especially if the client is located outside of a major metropolitan area.

- One drawback to service-level agreements is the difficulty of defining expected performance and then measuring it. Reliability Plus, a product offered by University Computing, monitors most devices in a computer center, giving a daily analysis of any hardware failures. It also compares each item's performance with that of similar equipment in other installations. Each Reliability Plus user receives a monthly printout showing how well its facility did in relation to more than 600 other centers that use the package. This allows the user to make two important comparisons: he can see how well his own vendor does compared with other vendors, and he can see how the service he receives compares to that received by other customers. This capability increases the value of service agreements.

©1983 by INPUT. Reproduction Prohibited.

- Close monitoring of a system is crucial to achieving high uptime percentages. The effort must be continual, intense, and part of an ongoing commitment to reliability. An organization setting out to attain close to 100% uptime should expect to put in at least a year's hard work before reaching its goal. Then it must maintain that effort to stay at the top.

- In summary, there will be an increasing proliferation and expansion of service products offered, including, but not limited to the following:

  - Installation support.

  - Training.

  - Documentation.

    . User.

    . Systems.

  - On-site service.

    . Eight to twenty-four hours per day.

    . Five to seven days per week.

    . One-, two-, four- or eight-hour response.

  - Dedicated site service.

  - Remote diagnostics access.

  - Depot resupply.

©1983 by INPUT. Reproduction Prohibited.

- Removals.

- Moves, changes, and upgrades.

- Service and operational audit.

- Consulting assistance.

©1983 by INPUT. Reproduction Prohibited.

V TACTICAL CONCLUSIONS AND RECOMMENDATIONS

V TACTICAL CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

- The analysis and evaluation of key technological and product trends, and research into user needs, requirements, and key problems for large systems suggest that there is significant concern about service and support among users of large mainframe systems.

- Users are focusing more on the quality of hardware and software response, on maintenance and repair, and on costs. This increasing level of dissatisfaction with the hardware and software maintenance and repair services offered by large systems vendors in general, and Burroughs, Perkin Elmer, and Tandem in particular, is shown in Exhibit V-1. This view by users is supported by trends shown in other related topics, including:

  - Growing interest in third-party maintenance as an alternative to the original equipment vendor's service offerings.

  - Increasing interest in fault tolerant and ultrareliable mainframe systems, particularly for on-line interactive applications.

  - Increasing willingness to pay a premium for guaranteed response time, repair time, and up time, as shown in Exhibit V-2.

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT V-1

OVERALL EVALUATION OF SERVICE POSTURE

(Satisfied, Overkill, or Disatisfied/Problem Area - Based on Percent Respondents from Survey)

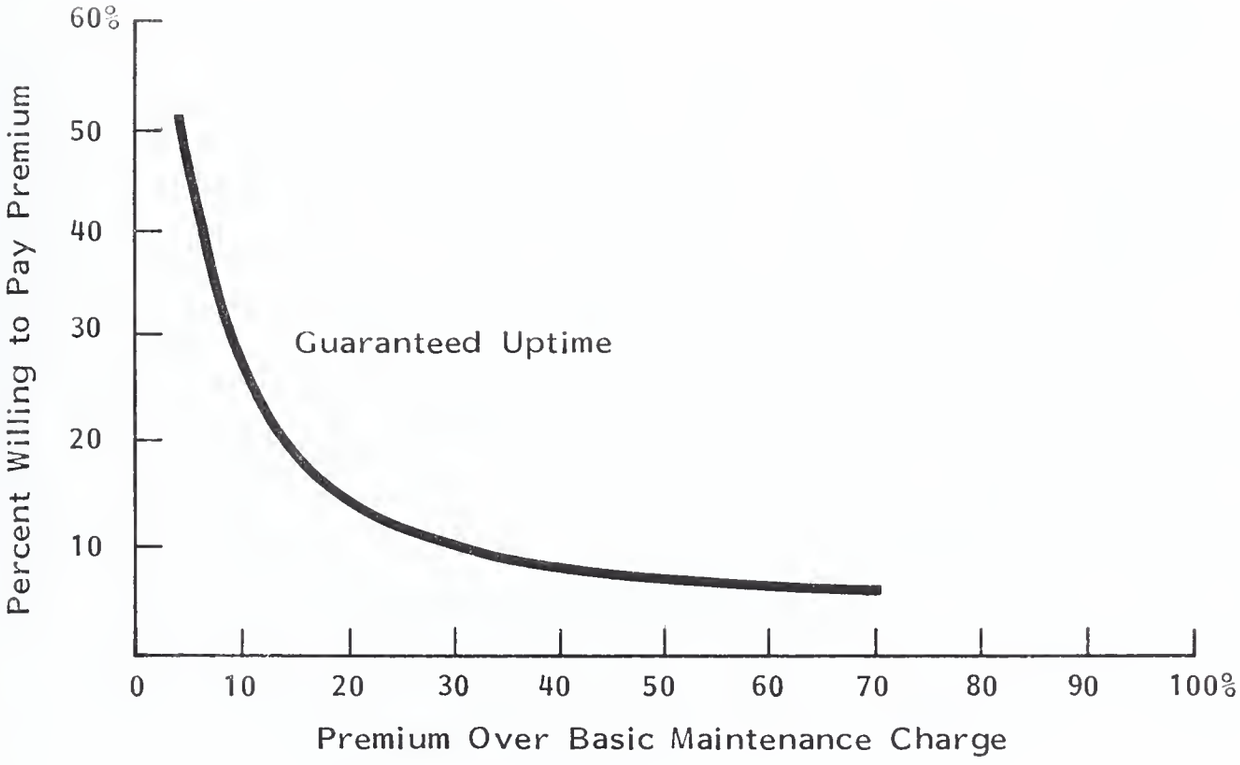
SERVICES AREAS	VENDOR												
	Amdahl	Burroughs	CDC	Cray	DEC	Data General	Honeywell	IBM	NAS	Perkin Elmer	Tandem	Univac	Overall
Environmental Planning	●	●	●	●	●	●	●	●	●	–	●	●	●
Physical Site Planning	●	P	–	●	●	–	●	●	●	–	P	●	●
Consulting	●	●	●	●	●	●	●	●	●	–	–	–	●
Documentation	●	P	–	●	●	P	P	●	P	P	–	P	P
Training	●	P	●	P	●	–	●	●	P	–	●	P	●
Installation Planning	–	P	–	●	●	●	●	●	●	–	–	●	–
Hardware Maintenance	P	P	P	●	P	P	P	●	●	P	P	P	P
Software Maintenance	P	P	P	P	P	P	P	P	P	P	●	P	P
Supplies Sales	–	●	–	●	–	P	●	●	P	P	–	P	–
Add-on Sales	–	●	●	●	●	–	P	●	●	–	●	●	●
Site Audits	–	●	–	P	–	–	●	–	●	–	●	●	–
Relocation	●	–	–	–	●	–	●	●	●	●	P	●	–
Deinstallation	●	●	●	●	●	–	●	●	●	–	–	●	–
Overall Rating*	8.53	6.75	7.46	8.60	7.83	7.43	7.27	8.25	8.37	6.95	6.90	7.55	

* Scale of 1 - 9 (9 = Highest) ● = High Satisfaction – = Overkill P = Problem - High Disatisfaction

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT V-2

WILLINGNESS TO PAY PREMIUMS FOR EXTENDED SERVICES

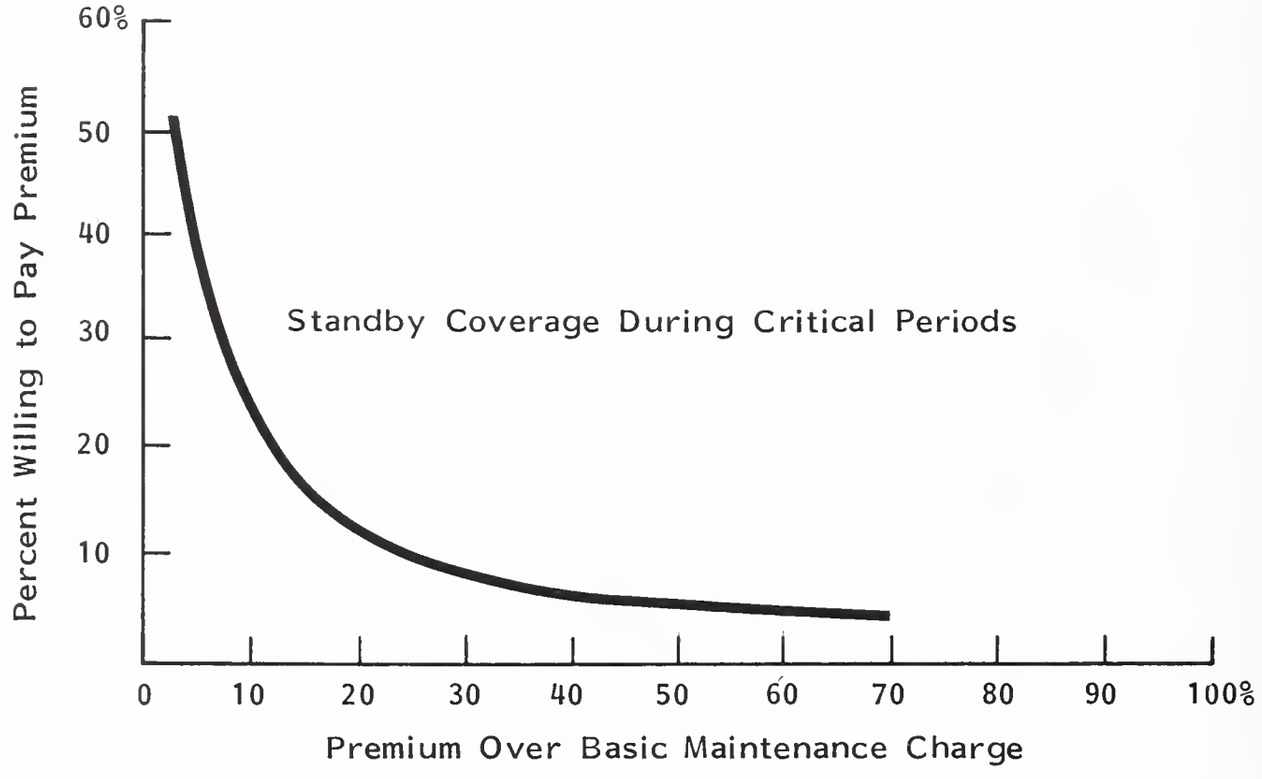


Continued

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT V-2 (Cont.)

WILLINGNESS TO PAY PREMIUMS FOR EXTENDED SERVICES

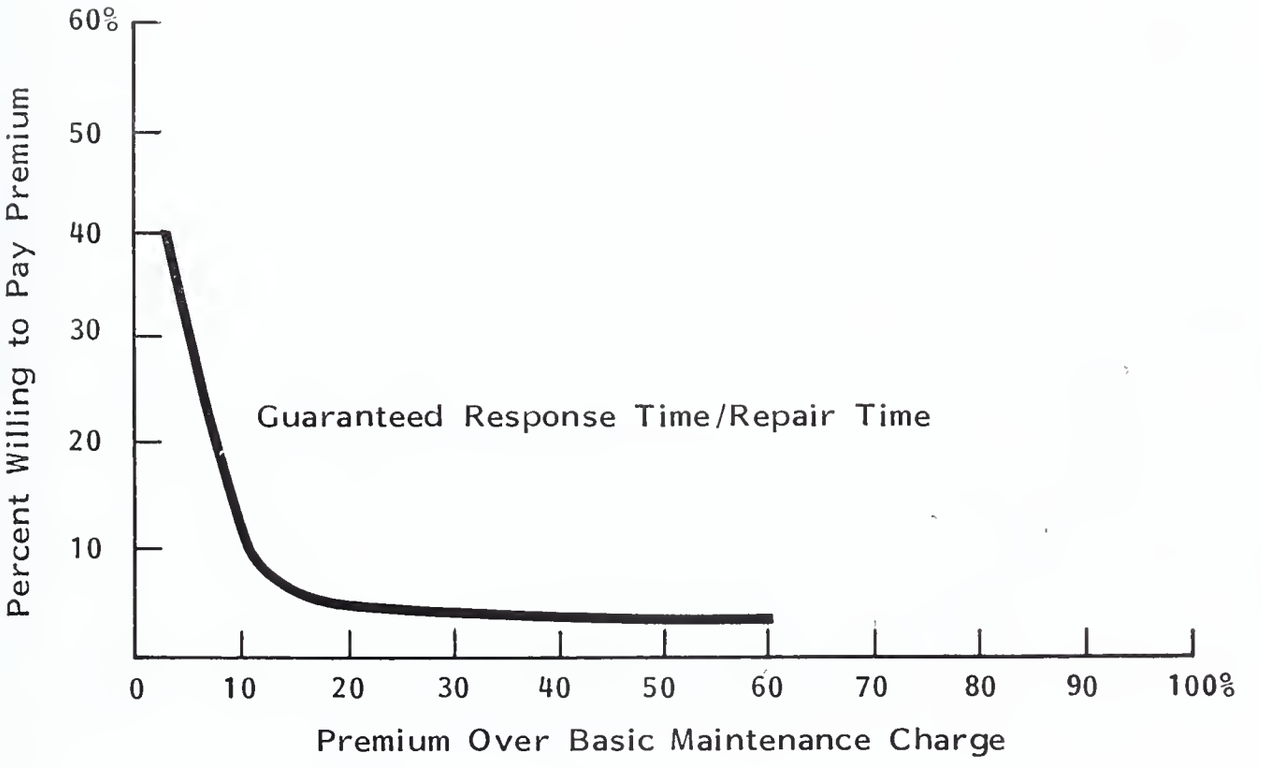


Continued

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT V-2 (Cont.)

WILLINGNESS TO PAY PREMIUMS FOR EXTENDED SERVICES

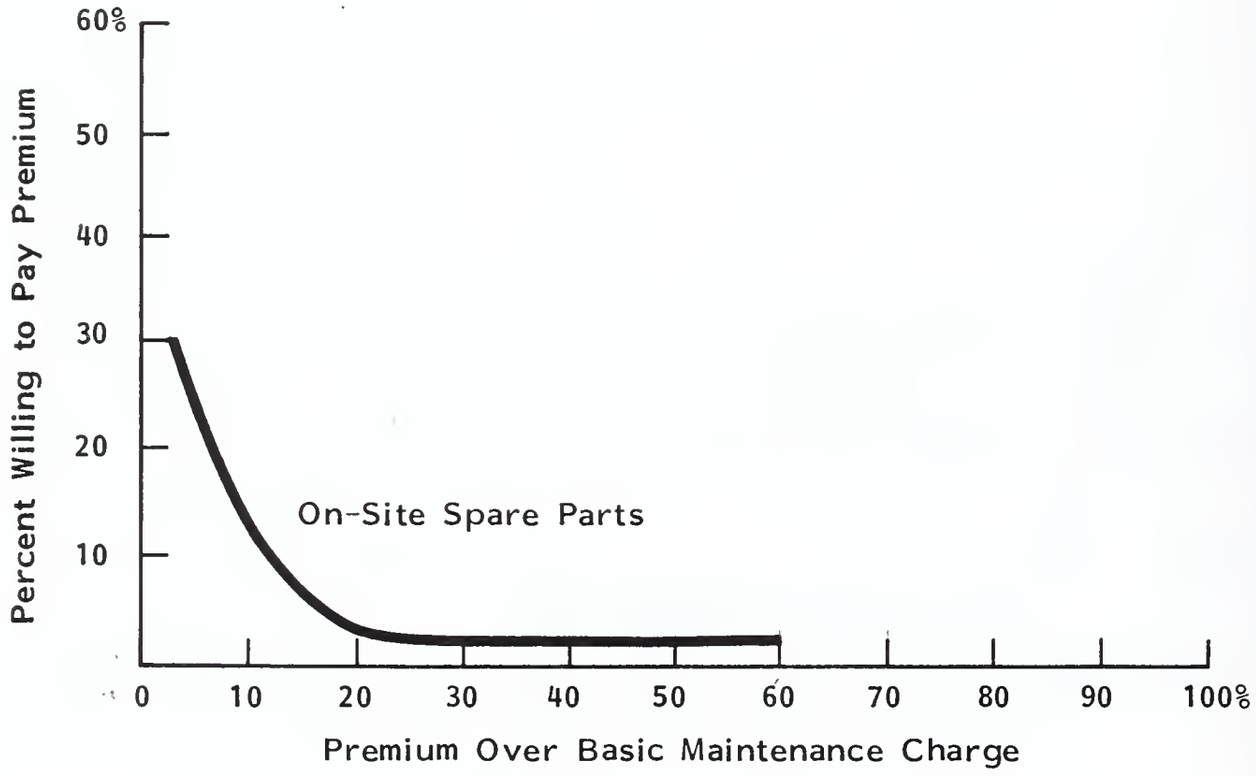


Continued

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT V-2 (Cont.)

WILLINGNESS TO PAY PREMIUMS FOR EXTENDED SERVICES

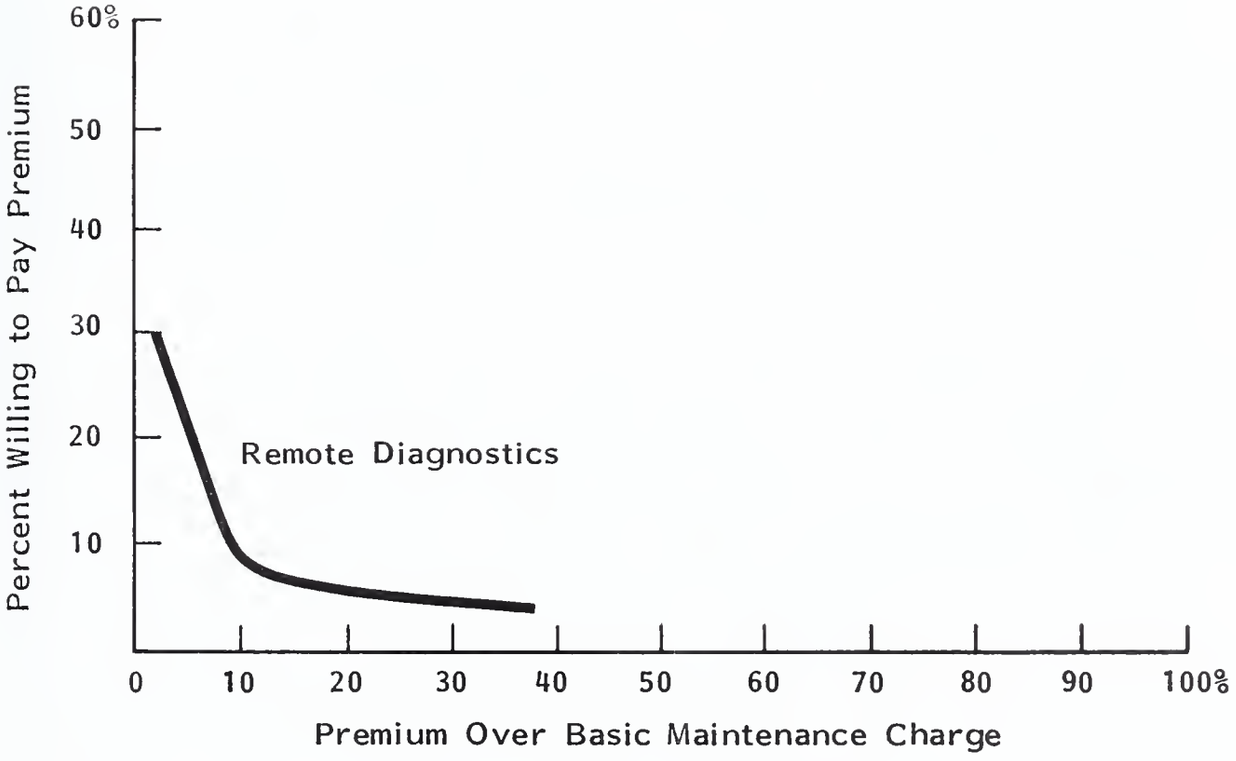


Continued

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT V-2 (Cont.)

WILLINGNESS TO PAY PREMIUMS FOR EXTENDED SERVICES



©1983 by INPUT. Reproduction Prohibited.

B. MAJOR TACTICAL PROBLEMS

- The evaluation of the data available suggests that while large-systems-based service organizations are apparently responding within the timeframe required by most users, the hardware maintenance problem was primarily traceable to the vendors' inability to correct the problem once on-site. This is related, in part, to the fact that most large-systems service organizations primarily track and control response time (elapsed time from call received to arrival on-site), rather than overall response and repair time (i.e., including repair time). This lack of control over the overall response/repair time parameter (with a primary focus on response time) can only provide the service manager with a considerably different picture from that of the user, who is much more concerned about the total elapsed downtime than he is with initial response on-site.

- In this context, it is important to note that many of the large-systems service organizations have failed to coordinate under a single management organization all appropriate resources necessary to satisfy and support service in the field, including spare parts supply, technical assistance, diagnostics, etc. Thus it is possible that a service engineer arrives on-site within the required time; but by not having the right parts or the right technical information or data, the engineer may have to return to fully effect the repair. For those organizations that separate material/logistics supply and/or technical diagnostics and assistance from the field service operation, this delay is not considered to be field service organization related. Yet, from the standpoint of the customer, obviously the overall elapsed time between the call for service and the completion of a fix is the critical factor.

- The problem with the total management of software maintenance is even more severe. Most large-system service organizations do not meet customer requirements with respect to full software failure, partial software failure, or minor degraded software failure, as shown in Exhibit III-4.

©1983 by INPUT. Reproduction Prohibited.

- In summary, the major tactical problem facing the management of most large-scale systems service organizations is the need to develop more effective methods for control of the overall elapsed time for fixing hardware and software failures, the need to insure fully controlled delivery of all required resources (technical manpower on-site, parts, material, and technical diagnostics), and the need for timely, responsive, and efficient service.

- Other areas requiring the attention of particular vendors include:

  - The need for improved documentation for user and systems operations.

  - The need for improved training, including computer-aided instruction, materials, and training aids, as well as in-plant, locally available training courses.

- Documentation and training needs are particularly acute with respect to large-systems vendors that supply advanced computer systems that are involved in communications and telecommunications network control, distributed data processing management, and multiprocessing and multitasking operations.

C. IMMEDIATE CHALLENGES FOR SERVICE MANAGEMENT

- For the large-systems service organization a number of challenges exist that must be recognized, understood, and dealt with, both strategically and tactically. These major challenges include:

©1983 by INPUT. Reproduction Prohibited.

1. INCREASING USE OF AND INTEREST IN THIRD-PARTY MAINTENANCE

- In addition to the existing third-party maintenance service organizations (RCA, TRW, CDC, Western Union), many of the larger service forces of mainframe manufacturers and office automation suppliers are entering into the third-party maintenance business (e.g., Honeywell, NCR, and Xerox). This represents a significant threat to the service organizations of existing OEM service suppliers. This is particularly true for OEMs whose customers have expressed dissatisfaction about the quality and responsiveness of hardware/software maintenance of the large, mainframe systems. This growing competition from present and potential third-party maintainers represents a tactical threat for the large-systems service suppliers; it also represents, of course, an opportunity that will be dealt with in a later section of this report.

2. TREND TOWARD FAULT-TOLERANT AND REMOTE DIAGNOSTICS TECHNOLOGY FOR SERVICE DELIVERY

- The second major challenge comes from technological developments in the implementation of fault-tolerant systems, redundant systems, and remote diagnostic-equipped systems, developments that minimize the importance of service organizations, particularly with respect to on-site hardware and software maintenance and repair. This appears, on the surface, to represent an advantage to the service organization, through reduction in the actual amount of on-site service required.

- It is important to recognize that such technological developments increase the cost of the initial acquisition, sometimes as much as 20% to 40%, and that this represents a factor that will be considered by the typical user in his evaluation of hardware vendors.

- In essence, highly fault-tolerant and fully remote diagnostics-equipped large systems fill a specific market niche rather than suggest the replacement of all large mainframe systems.

©1983 by INPUT. Reproduction Prohibited.

- The primary challenge for the service organization is to develop the appropriate cost-accounting and management control mechanisms to avoid providing a higher level of service than is required for such systems and, therefore, to be able to reduce the direct cost of field service for equipment that, because of its inherent design, does not require the same level of service as other standard mainframes. This generally requires a much greater degree of accuracy in cost accounting and control of service reaction, responsiveness, and allocation than most service organizations have developed.

- In essence, the primary challenge to the service organization of fault-tolerant and remote diagnostic systems is to avoid overkill. The strategy is to reduce the delivery costs of actual service to users who have in their initial purchase decision expressed a willingness to pay frontend loaded costs for higher levels of uptime and reliability.

3. EXPANSION OF THE SERVICE MANAGEMENT CONCEPT IS INTENDED TO DELIVER FULL SERVICE TO A SPECIFIC USER

- The third major challenge relates to the short-, mid-, and long-term role of the large mainframe in most organizations. In essence, as indicated in the previous analysis, at least three major roles can be contemplated for large mainframe systems.

  - A role as the central coordination and network management system for a fully distributed network that consists of distributed microprocessors, mini systems, and personal computers.

  - A role as a central data base and batch processor manager that operates as a single node on a fully distributed processing network.

  - A role as the central supercomputer that provides on-line real time and batch processing capabilities via intelligent or dumb terminals or PCs

©1983 by INPUT. Reproduction Prohibited.

that operate through local-area network support or from terminals directed toward the main system.

- In each of these cases, the role of the large mainframe system is critical. However, of greatest tactical (and strategic) importance is that in each case the large mainframe must fully interact with other data processing, telecommunications, office automation, and peripheral units, including a wide array of technology (i.e., terminals, printing units, telecommunications modules, mini processors, personal computers, etc.).

- To avoid finger pointing and to provide total management control of service responsiveness and cost, it is increasingly important for the service organization of large mainframe systems to move toward a full service management concept, one in which the service organization is providing total managed service for both the mainframe and the major elements and nodes of the network connected to the mainframe. In essence this is a direct alternative to pure third-party maintenance in which the service organization role is one of managing total service for both OEM-produced equipment and foreign equipment, although the service organization may not necessarily provide the actual direct service but may merely subcontract or control service response.

4. IMPROVEMENT OF PRODUCT MANAGEMENT AND SUPPORT

- The fourth major tactical challenge lies in the need to more effectively manage and control the data base associated with large systems' installed base.

- The increasing emphasis on uptime, reliability, and maintainability requires the service organization to more effectively manage the data associated with failure rates and repair times, and to analyze the data by problem, symptom, and cause-corrective action. The desire is to design more reliable and maintainable products in the future and to recognize the need for, and to effectively manage and control, engineering changes that correct specific design issues and failure modes.

©1983 by INPUT. Reproduction Prohibited.

- Historically, the service organization has not been involved in product management responsibilities; normally this has been a function assigned to marketing. However, with the increased emphasis on service and the increasing complexity associated with the role of the large system as a network controller and data base manager in a fully distributed data processing network and large support computer complex, the reliability, failure rate, and repair data and trends become increasingly important in the management of the product and new product design specifications.

- Another challenge is the need to establish and effectively control the information relating to failures, problems, causes, and corrective actions, and to provide a quantitative basis for evaluating the tradeoff between reliability and uptime, and ongoing service support - in essence to introduce product management as a part of the functionality of the service organization and allow the service product manager to work on a direct one-on-one basis with the marketing product manager.

- In essence the tactical challenges to field service managers in the immediate future relate to the threat of third-party maintenance, the need to more effectively manage and control overall service response and repair times for hardware and software maintenance, the need to introduce full service management systems, and the need to introduce product planning to the service organization.

D. RECOMMENDED TACTICAL ACTIONS TO RESPOND TO SERVICE CHALLENGES

- The recommended actions required in order to respond to the service challenges and opportunities identified above include:

©1983 by INPUT. Reproduction Prohibited.

1. ESTABLISH FORMAL SERVICE RESPONSE AND REPAIR TARGETS FOR HARDWARE AND SOFTWARE

- It is critical that the service organization establish, at least internally, specific response and repair targets that form the objectives and goals of the service force. These targets should be set and managed by market segment and product line. Actual performance should be tracked against targets to identify overages (i.e., where the elapsed time exceeds the target) and overkills (i.e., where the elapsed time is significantly less than the target).

- While most large-system service organizations have established targets for service levels and objectives for hardware response in general, there is a lack of such targets with respect to overall elapsed time, hardware maintenance, and specific objectives for software maintenance and repair. The setting of these targets and specifications and their implementation as part of a managed control system is critical to improving service efficiency and effectiveness with respect to large systems.

2. IMPLEMENT A FULLY INTEGRATED SERVICE MANAGEMENT CALL-HANDLING DISPATCH AND CONTROL SYSTEM

- Most large-systems service organizations have introduced some type of computerized assistance to support initial call handling on a regional or national basis, although some service organizations continue to coordinate and control service calls on a local-branch or district basis. A critical challenge of large-systems service is the increasing role of the large system as an overall network controller and as a fully distributed data base and processing complex. This, in turn, generates the need to introduce a higher level of regional or national control of all service calls for a given customer, particularly the large nationwide user.

©1983 by INPUT. Reproduction Prohibited.

- An integrated call-handling and dispatch system should be implemented that is interconnected to technical assistance for remote diagnostic screening, including capabilities for software and hardware maintenance.

- In essence it is essential to introduce a coordinated system that will manage and handle calls from reception to completion, including screening and initial diagnostic review of all calls, thus converting the call-handling process from a simple handoff (i.e., message handling) to a managed approach for the control and coordination of the call from the time it comes to completion. Thus, the service call requiring both hardware and software assistance would be managed through the regional or national service management system to ensure that full resources are allocated and directed toward specific customer problems.

- Use of the TAC/Remote Diagnostic Center as part of every call would ensure the most efficient and effective response to hardware and software problems. In addition, if a part is required in order to successfully complete the assigned call, the parts resupply issue would also be managed and supported by the central service management system.

- In essence, most of today's systems for call handling and dispatch in large-system service organizations are oriented primarily toward initial receipt of the call; the call is then handed over to a hardware service engineer for action.

- These systems fail to provide overall management of the call, including a managed approach to the coordination of hardware and software maintenance and repair, the tracking of calls in order to ensure controlled escalation of management actions in support of software, and the provision of and material/logistics needs in the event that an open service call's elapsed time exceeds certain established thresholds or targets.

©1983 by INPUT. Reproduction Prohibited.

- It is specifically recommended that a more managed systems approach be introduced at the regional and national level to ensure that the full resources of the services organization are appropriately directed and managed with respect to the arrival of individual service calls.

3. INTRODUCTION OF PRODUCT MANAGEMENT FUNCTION

- The third tactical suggestion is the creation of a product management function within the field service organization, involving the establishment of a product management group within the staff of the planning organization or as part of the technical assistance and support group of the field service organization. This product management group's primary responsibility would be to collect, analyze, evaluate, and manage the failure rate and repair time data associated with individual products. It would also be to provide a technical interface between marketing, engineering, and manufacturing, and the overall product management function (with respect to the design/reliability tradeoff in the introduction of new products, engineering redesign, and phase-out of existing products).

- In essence the service product manager would be concerned with the management of total service support for the life cycle of the product. For the products under his direction, the product manager would provide continuing monitoring, analysis, and evaluation of product failure rates, repair times, and service and support characteristics. The service product managers would also act as a responsible interface for new product introduction, particularly relating to the determination of the tradeoff in the level of reliability and maintainability to be built into the product, versus the cost of after-sales support.

4. OTHER TACTICAL/STRATEGIC INITIATIVES

- Other initiatives should be developed in response to the above trends. These initiatives are outlined below but discussed in more detail in the strategic analysis.

©1983 by INPUT. Reproduction Prohibited.

a. Third-Party Maintenance

- Using the existing installed base of the large-scale systems, the field service organization supporting large-scale systems should seriously consider possible entry into the third-party maintenance market. As indicated above, a significant trend is the utilization of large mainframe systems as either the data base manager or network coordinator that supports large, network-based distributed data processing systems and equipment.

- Under such a scenario large mainframe systems will have to interface directly with mini- and microprocessor systems, personal computers, intelligent terminals, and other peripheral equipment. Thus, it will become increasingly important for a service organization supporting large-scale systems to be able to provide service to the other elements on the network in order to avoid finger pointing and to allow the user to deal with a single service organization.

- The inability of large-scale systems suppliers' field service organizations to provide full (third-party) maintenance on other elements of the network could lead to a competitive disadvantage versus full, third-party maintenance organizations attempting to provide a total service management capability. Thus, entry into the third-party maintenance market represents a move that is tactically defensive, but strategic from an opportunity standpoint.

b. Development of the Service Management Concept

- Related to third-party maintenance, but an independent tactical and strategic thrust, is the development of new, integrated service products dealing with the management of the total service required by a particular office or business environment.

©1983 by INPUT. Reproduction Prohibited.

- Management of the full array of service required in the total office environment, including office automation, telecommunications, and data processing equipment, will be offered more often by service organizations as part of a new, innovative approach to creating a totally integrated service portfolio. Here again the service organization supporting large-scale systems should view the creation of a service management product as both a tactical defensive move to avoid losing business and a strategic offensive move to actually gain business.

- Both third-party maintenance and service management will be discussed as part of the strategic recommendations for action.

5. RECOMMENDATIONS

- In summary the tactical recommendations (based upon the key technical marketing and user trends discussed above) include:

a. Development of a Full-Service Portfolio

- Customers are demanding a greater array of integrated and managed service. These needs and requirements vary by market segment and product area. This is particularly true in the areas of banking, manufacturing, and government.

b. Development of a Strategic Approach to Service Pricing for the Service Product Portfolio

- While customers are increasingly focusing on the cost of service and the full cost of ownership, it is clear that customers are willing to pay more for the services they need. Little strategic planning has been applied in the past to service pricing. In most of the product markets, service has been priced in reaction to the prices of the industry leader. As a result, in large mainframes IBM has served as the basis for setting prices.

©1983 by INPUT. Reproduction Prohibited.

- The development of a full service portfolio and different levels of service for different markets and different products (i.e., fault-tolerant systems, remote diagnostic systems, etc.) requires a new approach to service pricing. In essence, the development of prices for the service portfolio must be based on a full evaluation of:

  - Cost of providing service.

  - Competitive prices.

  - Value in use.

- As indicated above, most service organizations have failed to control or measure service costs and very few have attempted to measure customer value-in-use for service. Thus, service prices have historically been driven by those of IBM. However, market studies show that the user does have specific, differing value-in-use for different classes of service, depending upon the market segment and product. This data should be used in developing an efficient service pricing strategy and tactics.

c. Development of a Service Management Concept of Service Operations

- Some customers of large systems have expressed an interest in the overall management of service for their installed base of office automation and data processing products.

- The development of this concept requires total management of the service call and the concurrent development of support systems for call handling and dispatch, technical assistance, and material/logistics inventory and pipeline.

- Users primarily want on-site service, and while they are willing to support and work with remote diagnostics, they prefer the service organization to provide integrated response where and when needed.

©1983 by INPUT. Reproduction Prohibited.

d. Development of an Approach to Third-Party Maintenance

- The rapid increase in third-party maintenance as a viable alternative requires that service organizations either enter the third-party service market independently, enter it as a part of a service management concept, or develop a competitive posture based on some combination of improved service quantity, improved responsiveness, and/or price reductions.

©1983 by INPUT. Reproduction Prohibited.

VI STRATEGIC ISSUES IN FIELD SERVICE

VI STRATEGIC ISSUES IN FIELD SERVICE

A. INTRODUCTION

- The development of effective long-range strategies for the servicing and support of large systems will be, to a large extent, dictated by the overall business strategy of the service organization with respect to one of three possible support scenarios.

1. SCENARIO ONE: EMERGENCE OF LARGE-/SUPERCOMPUTER-BASED SYSTEMS

- Introduction of large-/supercomputer-based systems with multiple processors as the primary large-system installed base will significantly reduce the scope and responsibilities of the service organization after initial installation. To a large extent the responsibilities of the service organization would be increasingly focused on initial installation, training, shakedown, and debugging.

- Service after the initial warranty period will probably be done by either dedicated on-site customer staff or by a dedicated on-site technician under contract. The critical periods for large- /supercomputers will occur primarily three to six months after installation. Thus, the primary focus of the service organization will shift from long-term maintenance and repair to short-term installation, training, checkout, and testing.

©1983 by INPUT. Reproduction Prohibited.

2. SCENARIO TWO: INTRODUCTION OF FAULT-TOLERANT/REMOTE-DIAGNOSTICS-BASED LARGE MAINFRAMES

- The second scenario involves the emergence of a high degree of built-in fault tolerance and redundancy, coupled with extensive remote diagnostics capability in the large-systems installed base. In this scenario, in addition to installation, training, initial warranty support, and shakedown/tests, the responsibility of the service organization will shift more to central monitoring, management, and coordination of system uptime and reliability using a centralized facility.

- This will also involve increasing use of preventive maintenance scheduling, dispatch, and control. Under this scenario the capital investment required for centralized remote diagnostic monitoring and spare parts modules (replacements for failed subassemblies and circuit boards) will increase. The labor associated with on-site service will decrease.

3. SCENARIO THREE: CONTINUATION OF CURRENT DEPENDENCY UPON LARGE MAINFRAMES AS CENTRAL DATA BASE MANAGER OR NETWORK CONTROL SYSTEM FOR DISTRIBUTED DATA PROCESSING

- Under this scenario, the responsibilities for the service organization will continue to include installation and training as well as on-site service. However, such a scenario would involve a significant expansion of the role of the service organization as service manager, providing the capability for both hardware and software servicing support of the mainframe and associated terminals, microprocessors, and peripherals on the network to avoid "finger pointing."

- In essence, this scenario places the greatest burden of responsibility on the field service organization for initial installation, training, warranty, and the continuation of maintenance in a full service management capacity, in re-

©1983 by INPUT. Reproduction Prohibited.

sponse to partial or full failures of either the mainframe or elements of the system network controlled by the mainframe.

- Perhaps even more important is the increasing requirement placed on the service organization for in-depth technical skills and capabilities in telecommunications network management, software applications, repair, and improvement.

- The three overall strategic scenarios outlined above will affect the large mainframe systems service marketplace in different ways. The focus and recommendations driven by these scenarios are articulated in Exhibit VI-1, which shows the implications for strategic actions by the field service organization. The strategic impact and direction of each of these scenarios is outlined below.

B. STRATEGIC ORGANIZATION AND OPERATING CONCEPTS

1. LARGE SUPERCOMPUTER SERVICE SUPPORT STRATEGY

- The primary step that must be taken by the field service organization in response to the development and implementation of large supercomputer technology is the development of a separate organization for installation, training, documentation, and checkout.

- Each supercomputer will require customized capabilities to meet individual client needs with respect to hardware and/or software. Thus, installation planning and scheduling will become very important and will require the establishment of an individual project organization for each new site.

- It is anticipated that the large-systems field service organization supporting the supercomputer technology will have a structure, as shown in Exhibit VI-2,

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT VI-1

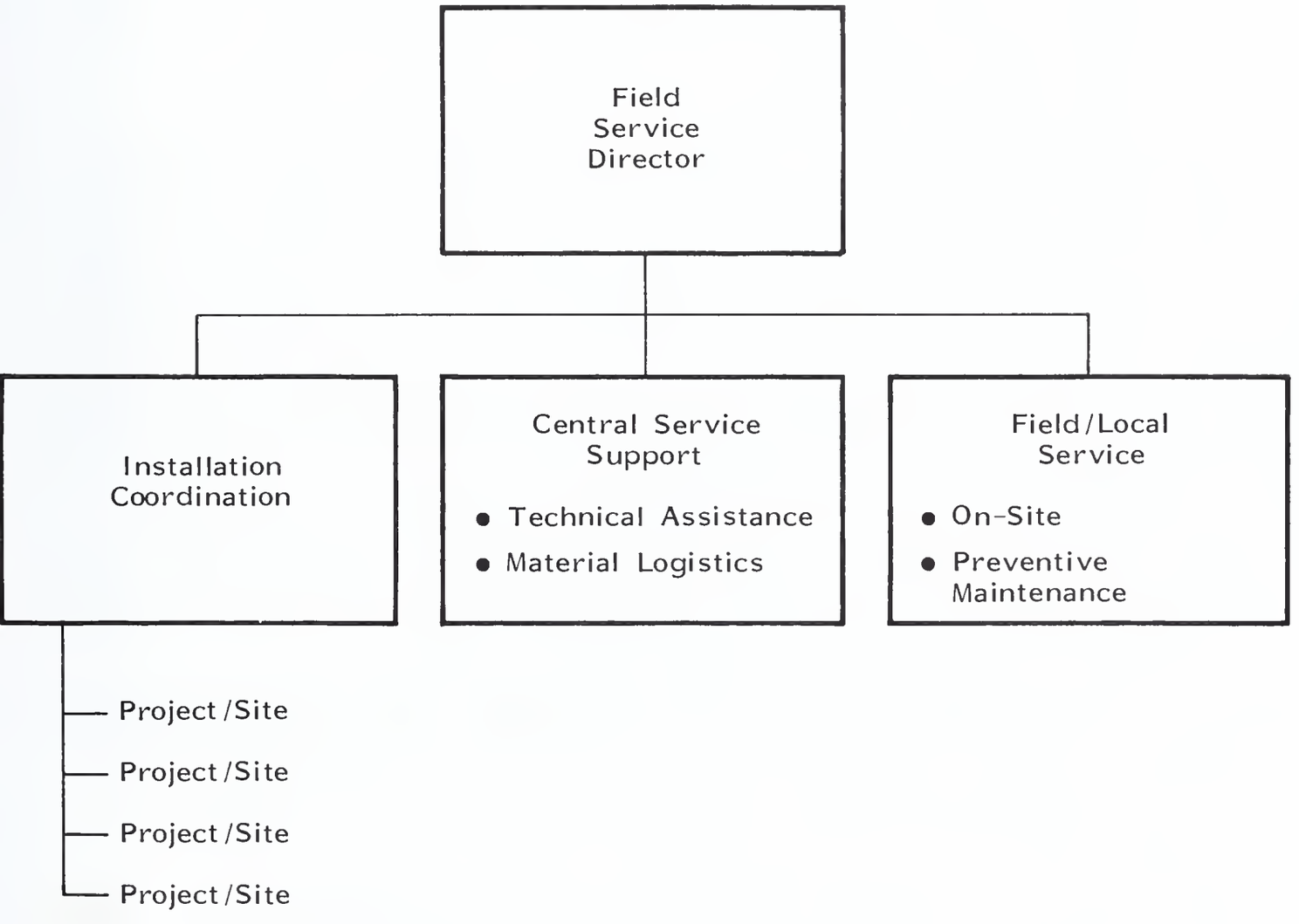
ALTERNATIVE SERVICE AND SUPPORT SCENARIOS
FOR LARGE SYSTEMS

SCENARIO	MAJOR FOCUS	SPECIFIC STRATEGIC RECOMMENDATIONS
1. Very Large Super-Computers	• Increased Emphasis on Installation and Ongoing Training and Documentation • Increased Use of Repair Depots for Modules	• Establish Separate Installation Program Office • Develop Approach to Pull-and-Replace Repair • Dedicated On-Site Repair Force
2. Fault-Tolerant and Remote-Diagnostics-Based Systems	• Increased Emphasis on Control Monitoring of Uptime Status • Development of Highly Accurate Statistical Data on MTBF by Module	• Implement Sophisticated Remote Diagnostics Technology • Increased Analysis of MTBF for Planned Preventive Maintenance
3. General Network-Based Mainframes	• Fully Coordinated Service Management • Controlled Service Response Time • Service Management	• Establish Integrated Central Call Handling and Dispatch System • Enter and Support Third-Party Maintenance Field • Expand Service Force Skills and Capabilities to Include Peripherals and Terminals

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT VI-2

SUPERCOMPUTER SERVICE ORGANIZATION



©1983 by INPUT. Reproduction Prohibited.

in which the field organization is broken up into an installation group and a service and preventive maintenance support group.

- Specific management systems must be developed for installation, planning, scheduling, and control of each individual project or site, taking into account shipment of equipment, scheduling of installation tasks, and scheduling and management control of support efforts like training operators and users, and supplying the documentation and specialized hardware and/or software modifications required by individual customers.

- It is also essential to establish a configuration management control system and data base for each individual site or installation; the service organization should be able to manage and control the configuration at each site and at the hardware and software level. A special set of parts and subassemblies should be maintained at unmanned depots at each site to support service engineers. With this approach a customer calls for service directly to the assigned site engineer rather than going through a central call-handling and dispatch operation at the national or regional level.

2. FAULT-TOLERANT/REMOTE DIAGNOSTIC LARGE-SCALE SYSTEMS DEVELOPMENTS

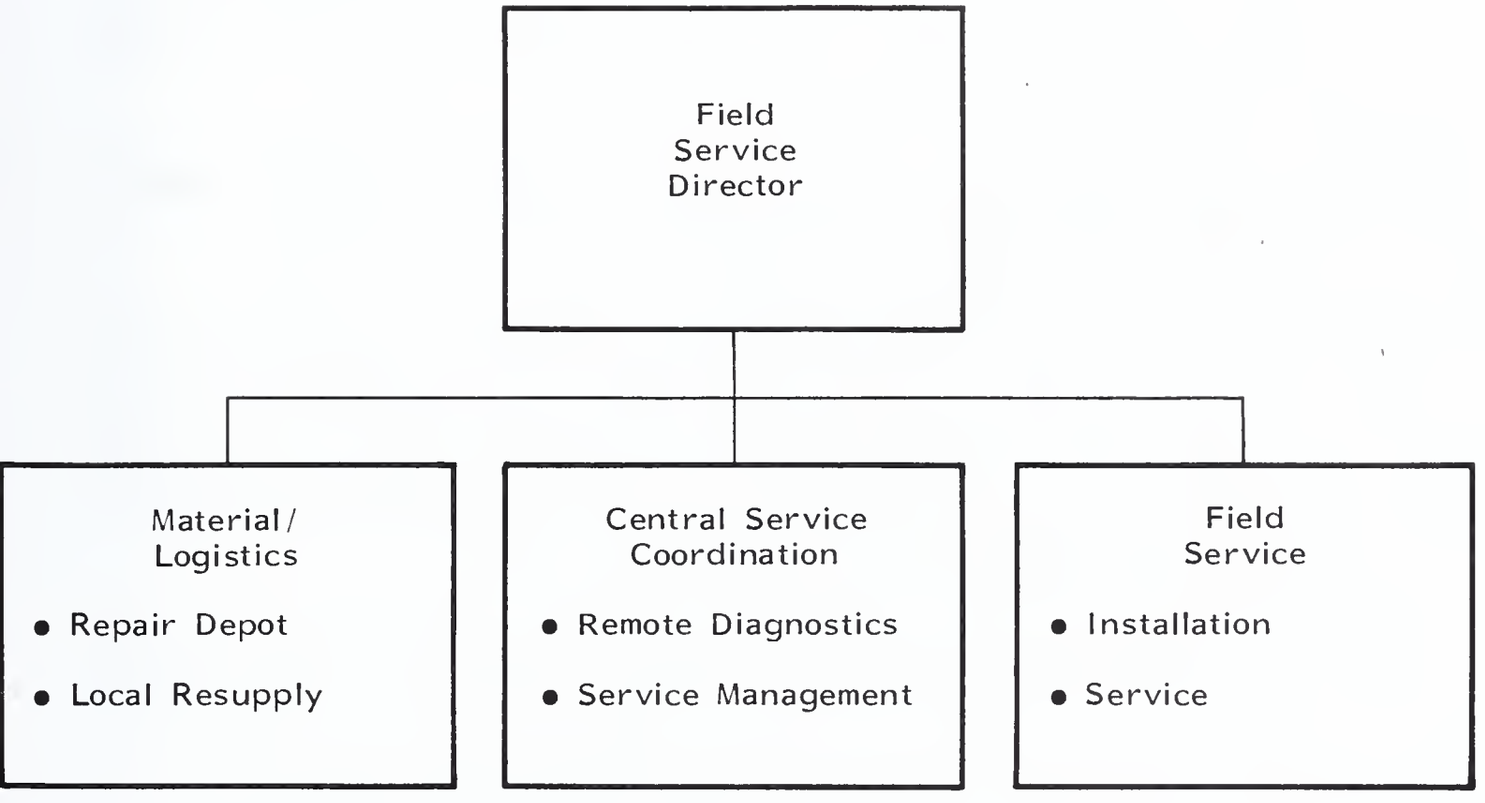
- The service organization in support of very fault-tolerant/remote-diagnostics-equipped large-scale systems will be organized, as shown in Exhibit VI-3, with a separate organization for central monitoring and remote diagnostics service and support.

- While both installation and service will be handled by the field service organization at the branch or district level, general service and support will be coordinated centrally in order to make use of past experience and statistical data as a framework for service problem screening and potential direct diagnostic evaluation and repair, and in order to maximize the productivity of the service force.

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT VI-3

FAULT-TOLERANT/REMOTE-DIAGNOSTICS-BASED
SERVICE ORGANIZATION



©1983 by INPUT. Reproduction Prohibited.

- In support of this overall strategy the service organization will have to make significant investments in the development and implementation of remote diagnostics and technical assistance centers and provide on-line real-time configuration control and data base access with respect to symptom, problem, probable cause, and corrective action recommendations data using a decision tree structure. Since this type of service organization will be heavily dependent upon a pull-and-replace philosophy for modules, it is vitally important that the service organization build up an efficient capability for depot-level repair and rehabilitation of modules and circuit boards.

3. LARGE MAINFRAME DATA BASE AND COMMUNICATIONS NETWORK-ORIENTED SYSTEMS DEVELOPMENT

- Under this approach, the field service organization will become much more critical to the end user; the large mainframe system will become the core unit of an integrated distributed network in which the mainframe data base and/or network control and processing capabilities are critical to the overall operation of the distributed data processing system network.

- The computer may also form the backbone of, or be tied to, PBX networking capabilities. In order to meet these requirements, the service organization must build a capability for service management, essentially providing the ability to service an array of different products tied to the central data processing system. The large mainframe system thus becomes the hub and network core.

- Providing high-quality responsive service manpower and material logistics support to meet service needs as they arise will become critical in this scenario.

- In order to efficiently manage this service responsibility on a nationwide basis, it is essential for the service organization to develop and implement a

©1983 by INPUT. Reproduction Prohibited.

nationwide integrated call-handling and dispatch system capable of operating at both the national and regional level, tied to a full capability for computerized dynamic material/logistic control.

- The skill levels of the service engineers will have to be increased so that engineers will be capable of not only servicing the mainframe but also handling the hardware and software interfaces with respect to telecommunications and networking needs.

- Finally, to avoid "finger pointing," a systems technician must also be capable of servicing non-vendor-related equipment on an "as required" basis. In essence, under the third scenario the field service organization is forced to provide, to some degree, a third-party maintenance capability on the equipment associated with the network and/or under the control of the large centralized mainframe system. The organization concept under this third-party scenario is shown in Exhibit VI-4.

4. SUMMARY

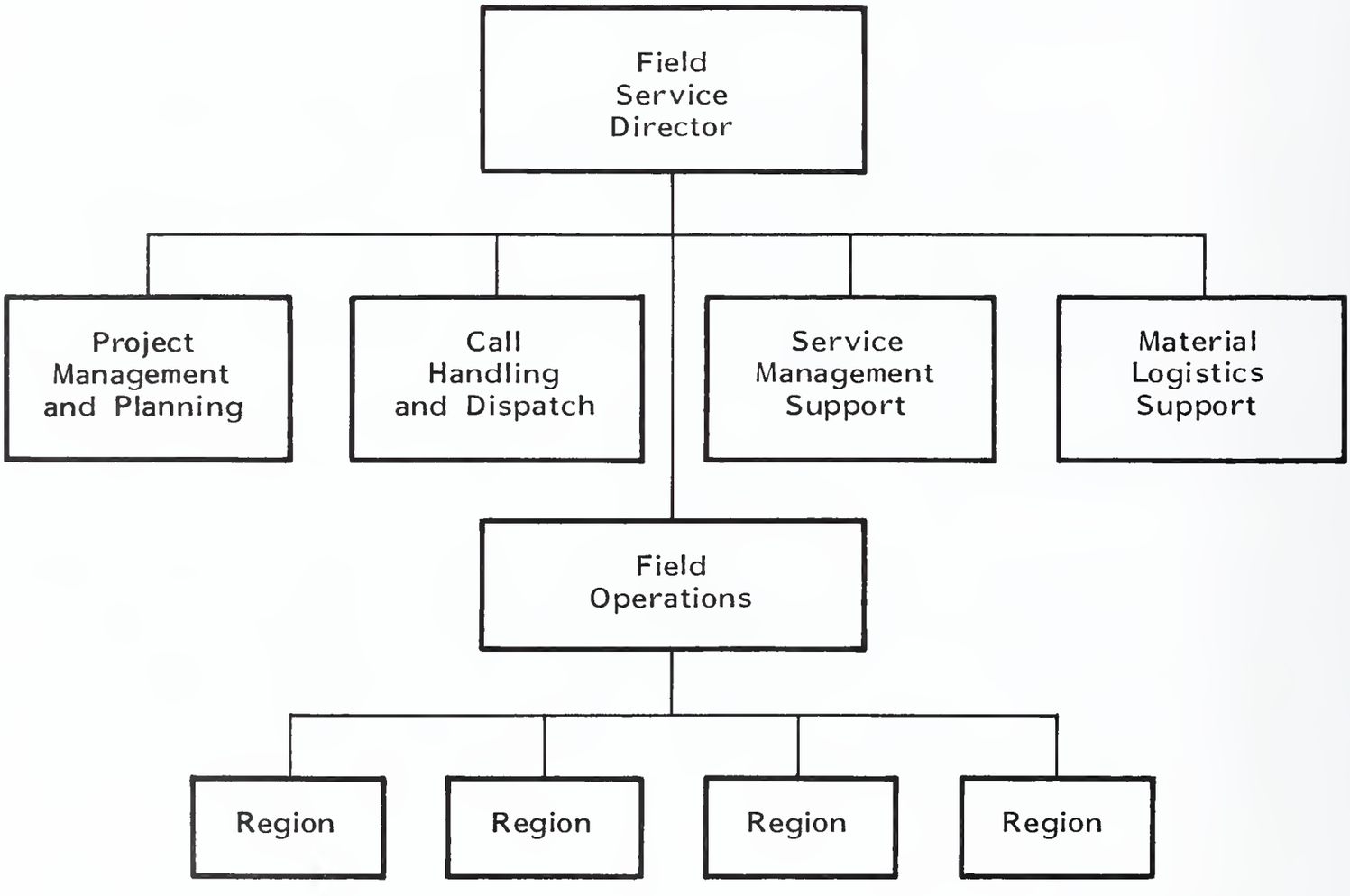
- Undoubtedly the product line development that will be produced by the major competitors in the data processing business (and large mainframe systems in particular) will include commitments to more than one product line, especially medium and small systems and office automation equipment. Thus, the pure strategy direction as outlined above will realistically be met through a more mixed strategy plan.

- In essence, except for the specialized large mainframe manufacturers that have products with a strong fault tolerance capability (such as Tandem, Cray with its orientation toward supercomputers, and Amdahl), most of the large mainframe organizations will, in all probability, expand their service organizations to provide a full capability for service and logistics support of full product range, as well as expand their management infrastructures to support remote diagnostics and technical assistance.

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT VI-4

BASIC FIELD SERVICE ORGANIZATION



©1983 by INPUT. Reproduction Prohibited.

- Clearly, it will be essential for all organizations to significantly increase the amount of management attention to installation, initial training, and documentation, especially for large mainframes. It is important that a specialized installation organization or department be established and operated on a project management basis to fully coordinate all aspects of initial site installation, including training, provision of documentation, support, full checkout, and turnover.

- Analysis of user attitudes toward service organization quality and responsiveness for large mainframes also clearly shows the necessity for more effective management and coordination of service calls, since a significant number of large mainframe users are either undersatisfied or significantly oversatisfied. Very few service organizations are effectively managing total elapsed response and repair times to meet customer needs.

C. RECOMMENDATIONS FOR LONG-TERM ACTION

- The major strategic trends and factors outlined above lead to both challenges and opportunities, as summarized in Exhibit VI-5. Recommended long-term action programs to meet these challenges and opportunities are also shown.

- In developing a long-term strategy to meet field service needs for large systems, it is important to recognize that several major changes are taking place that will affect both customer service/field service organizations of large systems and third-party maintenace organizations focusing on the large-systems marketplace. These factors relate to:

  - The significant trend toward integration of individual office automation products through voice/data networks, local-area networks, and extended PBX systems. To a large extent, we will see emerging two

©1983 by INPUT. Reproduction Prohibited.

EXHIBIT VI-5

STRATEGIC ISSUES AND CONCLUSIONS

MAJOR TRENDS AND FACTORS	LONG-RANGE CHALLENGES TO FIELD SERVICE MANAGEMENT	STRATEGIC OPPORTUNITIES	RECOMMENDATIONS FOR LONG-TERM ACTION PROGRAM, 1985-1988
Integrated office systems, combining data processing, word processing, and telecommunications functions. Growing importance of service to purchasing decision as products become increasingly commodity-like and life cycles shorten. Need for integrated, single source of service, especially in connection with fully integrated network-based office automation systems.	• Establish service as a separate line of business in support of general office automation technology. • Develop a full service organization to produce a full array of "products" for the office environment, including: – Installation and site planning – Installation – Hardware maintenance – Software maintenance – Moves and changes – Upgrades/configuration changes – Documentation – Training – Parts/supplies – Consulting – Other support service	• Service as a separate revenue and profit-generating line of business. • Service management as a framework/ concept for managing and delivering support.	• Establish full profit center service operation with supporting marketing, product and business planning, and financial/accounting functions. • Define full-service product portfolio. • Expand into third-party maintenance for those products under the service management umbrella.
Need for a comprehensive portfolio of services to support all aspects of after-sales support, including training. Need for establishment of a strategic pricing approach by market segment.	• Implement a comprehensive system to manage and control service as a business, including: – Installation planning and scheduling – Call handling and dispatch – Preventive maintenance scheduling – Technical assistance/remote diagnostics – Order processing and inventory control – Data base management – Reporting – Invoicing & cost accounting • Provide service portfolio customized to meet needs of individual market segments and niches. • Base pricing on evaluated combination of cost, competition, and value-in-use.	• Management and control of service delivery, responsiveness, and quality to profitably meet customer needs. • Increase profit margins and return on investment from service-based activities.	• Collect and allocate data on costs and revenues from individual products as a basis for service pricing. • Implement remote diagnostics and technical assistance centers accessible via a national 800 number. • Measure customer needs, requirements, and performance on a continuing basis. • Develop accurate data on MTBF and MTTR as a basis for new product planning. • Implement integrated system for service management control with common data base.

©1983 by INPUT. Reproduction Prohibited.

classes of users: those with large, integrated networks and those with individual standalone systems and units.

- The growing importance of improved service response and repair to ensure that the full system is available and operational, placing greater emphasis and focus on the need for service management and provision of a totally integrated service support effort after the initial sale.

- Increasing customer interest in cost containment and the provision of reliable, guaranteed responsive, quality service.

These trends all point toward a need for a comprehensive, integrated strategy that provides for the management of the service function, from point of sale to full after-sale support, including all the associated products, such as:

- Site and installation planning.
- Installation.
- Hardware maintenance.
- Software maintenance.
- Documentation.
- Training.
- Supply and parts sales.
- Moves and changes.
- Upgrades.

©1983 by INPUT. Reproduction Prohibited.

- Environmental and operational audit.

- Consulting and support services.

- Deinstallation/removal.

- In essence, the user will look toward the service organization for the full array of needs after the initial purchase. Larger organizations and users with a full array of products on an integrated systematic basis have a growing interest in those service organizations that can provide a total service management approach and offer the ability to control and manage this service on a regional and nationwide basis, with a full commitment to response and repair times, and to providing quality service and after-sales support.

- It would also be necessary for those service organizations wishing to participate significantly in the service and support of large systems to establish integrated computerized systems to manage and control full service/processing, including call handling and dispatch, remote diagnostics and technical assistance, management of the data base relating to customer installed base and configuration, and management and control of the logistics pipeline.

- Finally, the service organization must develop a comprehensive, strategic portfolio of service products and develop a service pricing approach strategy that is responsive to both the cost containment interests of certain market segments and to the need for highly responsive and quality service for other market segments.

- The size and growth of the large-systems market and the need for the integrated service will tend, in the long run, to create significant economies of scale and efficiencies in large, nationwide service organizations servicing an extensive installed base.

©1983 by INPUT. Reproduction Prohibited.

- For those organizations with large service functions and a developed service management infrastructure, basic prices for after-sales service, installation, maintenance, and repair will drop. These organizations are currently providing installation service at approximately 15% to 30% of acquisition price, and after-sales maintenance at approximately 8% to 14% of acquisition price annually.

- On the other hand, premium prices from the standard service base will increase to provide a closer correlation between the value-in-use needs of market segments requiring specialized or highly responsive service, versus those market segments that are more interested in cost containment. This will place the smaller service organizations attempting to provide national service at a competitive disadvantage and will undoubtedly force less efficient service organizations to choose one of two paths: to either grow by entering the third-party maintenance market, or be divested or acquired by other service organizations that can offer to the smaller manufacturer quality service at an economically efficient price.

- In essence, except for highly selective product areas, most products in the future will be serviced by large, nationwide service organizations on either a direct or third-party maintenance basis.

- In summary, the primary strategic challenge to service managers is to achieve economic and controlled growth through the introduction of integrated service products and to achieve the implementation of effective advanced management systems that will manage the full-service process and maintain tight controls on costs, levels of responsiveness, and service productivity.

- It will also be critical to introduce market-segment-oriented value-in-use pricing to enable appropriate recovery and return on investment and operating margins.

©1983 by INPUT. Reproduction Prohibited.

- For users of large systems other than supercomputers with fault tolerant and redundant systems, third-party maintenance organizations will offer an attractive alternative, particularly for national third-party service organizations that have established integrated systems to manage and control service dispatch and provide technical assistance, remote diagnostics, and hot-line support for the typical array of products normally found in the office operating environment.

©1983 by INPUT. Reproduction Prohibited.

APPENDIX: QUESTIONNAIRE

A. General Management

1. Which of the following services do you currently offer or plan to offer by 1985?

DIRECT SERVICE OFFERED	1983	BY 1985
a) Third-party maintenance	_____	_____
b) Facility maintenance management	_____	_____
c) Guaranteed availability (uptime)	_____	_____
d) Guaranteed response time	_____	_____
e) Guaranteed repair time (hardware)	_____	_____
f) On-site standby	_____	_____
g) Variable shift coverage (versus fixed schedules)	_____	_____
h) On-site spares	_____	_____
i) Guaranteed turnaround on software repairs	_____	_____
j) Remote diagnostics	_____	_____
k) Preventive maintenance and field changes during nonprime hours	_____	_____
l) System software maintenance	_____	_____
m) Application software maintenance	_____	_____
n) Depot maintenance (pickup)	_____	_____
o) Depot maintenance (carry/mail)	_____	_____
p) Local area network maintenance	_____	_____

©1983 by INPUT. Reproduction Prohibited.

2. Which of these secondary services do you offer or plan to offer by 1985?

ANCILLARY SERVICES OFFERED	1983	BY 1985
a) Environmental planning	____	____
b) Physical site planning (layouts)	____	____
c) Consulting services (hardware)	____	____
d) Consulting services (software)	____	____
e) Customer training	____	____
f) Installation management and coordination	____	____
g) Supplies sales	____	____
h) Add-on sales (additional equipment)	____	____
i) Upgrade sales (new equipment or features)	____	____
j) Site audits	____	____
k) Facility relocation	____	____
l) De-installation	____	____
m) Software sales	____	____

©1983 by INPUT. Reproduction Prohibited.

B. Field Support/Product Support

1. Please rate the influence of your field service management in the following activities. (Scale of 1-10: 10 = excellent, 5 = average, 1 = very poor.)

ACTIVITIES	RATING (1-10) 1983	1985
a) Product specification	_____	_____
b) Product design	_____	_____
c) Serviceability design	_____	_____
d) Documentation	_____	_____
e) Diagnostic development	_____	_____
f) Selection of test equipment	_____	_____
g) Spares requirements	_____	_____
h) Geographic control of sales	_____	_____
i) Exceptions to standard maintenance agreements	_____	_____
j) Product performance objectives	_____	_____
k) Quality control in manufacturing	_____	_____
l) OEM acceptance criteria	_____	_____
m) Customer education	_____	_____

2. To what extent has software support been integrated into hardware support structure? By 1985?

SOFTWARE SUPPORT ACTIVITY	1983	1985
a) System Control Software	_____ %	_____ %
b) Application Software	_____	_____
c) Maintenance of Third-party software	_____	_____

©1983 by INPUT. Reproduction Prohibited.

3. On a scale of 1-10 (10 = high) how important is it to you to offer the following types of services:

	1-10
a) Field support via remote diagnostics	_____
b) Field support via user self-diagnostics	_____
c) Telephone field support	_____
d) On-site field support	_____

4. What are your objectives and what did you achieve in these following measures of product performance; (break down by type of product e.g., mainframe, mini etc.)

PRODUCT TYPE	MEAN TIME TO REPAIR (hours)		MEAN TIME BETWEEN FAILURES (hours)		AVERAGE AVAILABILITY (percent)		MEAN TIME TO RESPOND (hours)	
	OBJ.	ACT.	OBJ.	ACT.	OBJ.	ACT.	OBJ.	ACT.
a) _____								
_____	____	____	____	____	____	____	____	____
b) _____								
_____	____	____	____	____	____	____	____	____
c) _____								
_____	____	____	____	____	____	____	____	____
d) _____								
_____	____	____	____	____	____	____	____	____
e) _____								
_____	____	____	____	____	____	____	____	____

©1983 by INPUT. Reproduction Prohibited.

5. Do you currently offer or do you plan to offer any of the following services?

	CURRENTLY IMPLEMENTED? YES/NO	IMPLEMENTED BY 1985? YES/NO
a) Remote diagnostics	_____	_____
b) Centralized dispatching	_____	_____
c) Modular, plug-in units for user to deliver to repair centers	_____	_____
d) Real-time incident reporting	_____	_____
e) Real-time IR (parts usage included)	_____	_____
f) Regional repair centers	_____	_____
g) Third-party repair centers	_____	_____
h) Third-party on-site maintenance	_____	_____

6. a) What do you see as the trend in capital investment in spare parts inventories?

YEAR OF MEASUREMENT	PERCENT OF GROSS SERVICE REVENUES FOR YEAR
1983 (most recent inventory)	_____%
1985 (projected)	_____%

b) Why, or could you comment on this trend?

Comment:_____

_____

_____

_____

_____

©1983 by INPUT. Reproduction Prohibited.

7. a) Have you announced or have you set a policy on the maintenance and support of local area networks serving competitive products? Yes/No_____

   b) Comment:

_____

_____

_____

_____

_____

_____

©1983 by INPUT. Reproduction Prohibited.

C. Personnel

1. Please identify your sources of new employees and rate them on a scale of 1-10. (1 = little or no importance, 10 = highest importance.)

SOURCE OF NEW EMPLOYEES	RATING (1-10)	
	1983	1985
a) Competition		
b) Trade schools		
c) Military schools		
d) Two-year college programs		
e) Four-year colleges		
f) Apprenticeship programs		
g) Other division in company		
h) Employee referrals		
i) Other:		

2. Do you provide in-company formal training? If so, in what areas?

	YES/NO
a) Indoctrination	
b) Basic training (apprentice level)	
c) Product (technical)	
d) Systems software (system)	
e) Applications software	
f) Management development	
g) Technological upgrading	
h) Other	

©1983 by INPUT. Reproduction Prohibited.

3. Do you (F) fully or (P) partially reimburse or otherwize provide financial support for:

	F/P
a) Education/training	_____
b) Relocation	_____
c) Company products/stocks	_____
d) Professional associations/memberships/journals	_____
e) Other _____	_____

4. Which personnel policies do you think have a significant impact on the satisfaction level of your employees?

FRINGE BENEFITS	1983	BY 1985
a) Life insurance	_____	_____
b) Hospitalization	_____	_____
c) Major medical (80% or better)	_____	_____
d) Limited medical (out patient)	_____	_____
e) Dental	_____	_____
f) Eyesight/glasses	_____	_____
g) Retirement	_____	_____
h) Disability insurance	_____	_____
i) Matched savings	_____	_____
j) Profit-sharing	_____	_____
k) Paid sick leave	_____	_____
l) Grievance procedures	_____	_____
m) Improvement programs for marginal performers	_____	_____
n) Exit interviews	_____	_____
o) Appraisal and counseling	_____	_____
p) Career path definitions	_____	_____
q) Pay for performance guidelines	_____	_____

©1983 by INPUT. Reproduction Prohibited.

5. What incentives are offered to field service employees?

INCENTIVES	MANAGEMENT		EXEMPT		NONEXEMPT	
	1983	BY 1985	1983	BY 1985	1983	BY 1985
a) Stock options	___	___	___	___	___	___
b) Performance bonuses	___	___	___	___	___	___
c) Suggestion awards	___	___	___	___	___	___
d) Periodic recognition awards ("FE of the quarter," etc.)	___	___	___	___	___	___
e) Special projects, foreign assignments, etc.	___	___	___	___	___	___
f) Award conferences, trips	___	___	___	___	___	___
g) Competitive scholarships for employees or family	___	___	___	___	___	___
h) Other: _____	___	___	___	___	___	___
_____	___	___	___	___	___	___
_____	___	___	___	___	___	___

©1983 by INPUT. Reproduction Prohibited.

6. a) How many direct labor field service personnel were hired in:

1983_____(forecast)

1985_____(forecast)

b) How many direct-labor field service personnel will leave your company in:

1983_____(forecast)

1985_____(forecast)

c) What are the major reasons for persons leaving your department or company?

	1983
i) Voluntary, no reason given	_____
ii) Left for higher salary, better total compensation	_____
iii) Released for company reasons	_____
iv) Promotion in another company	_____
v) Relocation by another company	_____
vi) Promoted within own company	_____
vii) Transferred to foreign subsidiary or other division	_____
viii) Other _____	_____
Total	_____

d) What are your present and future staffing levels in the following areas?

U.S. EMPLOYEES	1983	1984
i) Total employees in company	_____	_____
ii) Total in field service division	_____	_____
iii) Number of direct-labor FEs	_____	_____
iv) Number of field support engineers	_____	_____
v) Number of field supervisors	_____	_____
vi) Number of managers in field	_____	_____
vii) Line managers at headquarters	_____	_____
viii) FE staff managers (total)	_____	_____
ix) FE staff personnel (nonmanagement including administration)	_____	_____

©1983 by INPUT. Reproduction Prohibited.

7. 1983 annual salaries, office system field engineers (front-line product field service technicians)

JOB DESCRIPTION	TITLE	RANGE		AVERAGE PAID (actual)	AVERAGE GAIN OVER 1982 (percent)
		MAXIMUM	MINIMUM		
a) Entry-level trainee maintenance	Trainee				%
b) Qualified field service technician carries territory, requires occasional assistance, renders some aid to lower levels	Qualified Field Engineer				%
c) Senior-level field service technician: Generally gives more assistance than received, assigned field training duties to assist in development of first two categories	Senior Field Engineer				%
d) Qualified field service engineer in software support	Software Support Engineer				%
e) _____	Supervisor				%
f) _____	Line Manager				%

©1983 by INPUT. Reproduction Prohibited.

D. Financial/Administrative Operations

1. How do you measure changes in field service productivity?

MEASUREMENT METHOD:	YES/NO
a) Ratio of gross revenue carried per field service person	
b) Ratio of personnel to equipment by category	
c) Ratio of personnel to management	
d) Net ratio of expenses to revenue after cost of improvement	
e) Other	

2. Have you experienced productivity improvement in servicing in the following areas?

IMPROVEMENT	YES/NO	PRODUCTIVITY IMPROVEMENT (percent)
a) Remote diagnostics		
b) Repair centers		
c) Regional parts depots		
d) Centralized dispatch		
e) Support centers		
f) Field education		
g) Cross training		
h) Multiple territory assignments		
i) Other		

©1983 by INPUT. Reproduction Prohibited.

3. Please indicate the percentage of total operating revenues credited to the field service division coming from the following categories. (If fiscal is different from calendar, please supply FY dates.)

SOURCE OF REVENUE CREDITS	PERCENT OF TOTAL REVENUE	
	1983	1985
a) Warranty		
b) Third-party contracts		
c) Installation charges		
d) De-installation charges		
e) Consulting		
f) Parts sales		
g) Supplies sales		
h) Sales of ancillary equipment		
i) Sales of software products		
j) Maintenance of software products		
k) Sales discounts on maintenance		
l) Other_____		
m) Other_____		

4. Please indicate the percentage of total field service division expenses in the following categories (and supply FY dates if different from calendar year).

EXPENSE LINE ITEM	PERCENT OF TOTAL EXPENSES [use ( ) to indicate credit]	
	1983	1985
a) Direct labor		
b) Management and administrative		
c) Benefits		
d) Parts		
e) Depreciation		
f) Travel		
g) Education		
h) Logistics, repair depot, and other expenses not reported above		
i) Overhead		
j) Other significant categories		

©1983 by INPUT. Reproduction Prohibited.

5. What was your overall financial performance in the following field service catories?

FINANCIAL PERFORMANCE	FISCAL YEAR END _____	
	1983	1985
a) Field service revenue ($ millions)	_____	_____
b) Field service expenses ($ millions)	_____	_____
c) Pretax profit (percent)	_____	_____
d) Revenue per field service engineer (direct labor)	_____	_____
e) Direct expense per field service engineer (direct labor)	_____	_____
f) Fully burdened expense per field service engineer (direct labor)	_____	_____

©1983 by INPUT. Reproduction Prohibited.

6. a) Please describe the methodology your company uses to set maintenance prices (percent of purchase tested against cost of service projection, etc.):

_____

_____

_____

_____

_____

b) At what ratio of basic maintenance price to list price do you believe that:

i) Users will actively consider alternative sources	____ %
ii) Users will definitely contract third party or maintain own equipment	____ %
iii) Users will refuse to buy the original product, given the option	____ %

c) How frequently do you expect to change prices of maintenance:

Comments: _____

_____

_____

_____

d) Do you offer discounts for:

	PERCENT DISCOUNT
i) User assistance in remote diagnostics	____ %
ii) User replacement of plug-in modules or units	____ %
iii) User delivery of plug-in modules or units to repair center	____ %
iv) Relaxed requirement on response time	____ %
v) User purchase of spare parts kits	____ %
vi) Other: _____	____ %

©1983 by INPUT. Reproduction Prohibited.

7. a) Are your maintenance contracts: (i) automatically renewed_____or (ii) negotiated each renewal cycle?_____

   b) What is the length of your normal contract?_____(months)

   c) Do you normally invoice (i) monthly_____, (ii) quarterly_____, (iii) semiannually_____, (iv) annually_____, (v) other_____.

8. a) Has your field service division implemented a field quality assurance program or other formal operational audit? Yes/No

   b) Comment: _____

_____

_____

_____

_____

9. What is the average cost breakdown of a typical fault call? (Please respond for products your company services.)

PRODUCT SERVICED	TOTAL COST (dollars)	DIRECT LABOR (percent)	TRAVEL (percent)	PARTS (percent)	OVERHEAD & SUPPORT
Large mainframes					
Medium mainframes					
Small systems					
Peripherals					
Terminals					
Word processors					
Personal computers					
Copiers, facsimile					
Work stations					
PABX, PBX					
Teleprocessing/communications					

©1983 by INPUT. Reproduction Prohibited.